MAY 15 1922

Engineering Library

For Water-Works Engineers

May 11, 1922

Engineering News-Record

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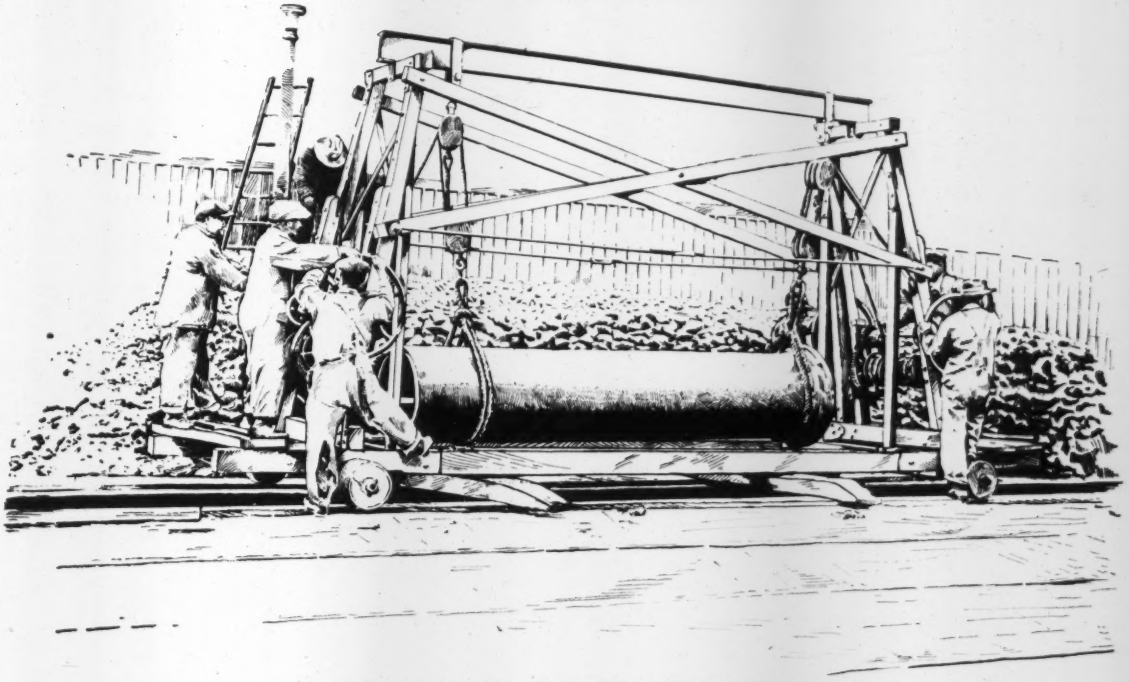


Lowering Pipe in Trench for Water Main in Detroit

Construction

How Detroit Selects and Operates the Equipment for Building Water-Works Extensions.
Placing a Submerged Intake Without a Diver in San Francisco; *G. W. Pracy.*

Operation

A Central Repair Shop for the Philadelphia Water-Works, *John M. Broggini.*
Diesel Engines Furnish Power for Gloucester, New Jersey, Water-Works; *W. De Witt Vosbury.*

Purification

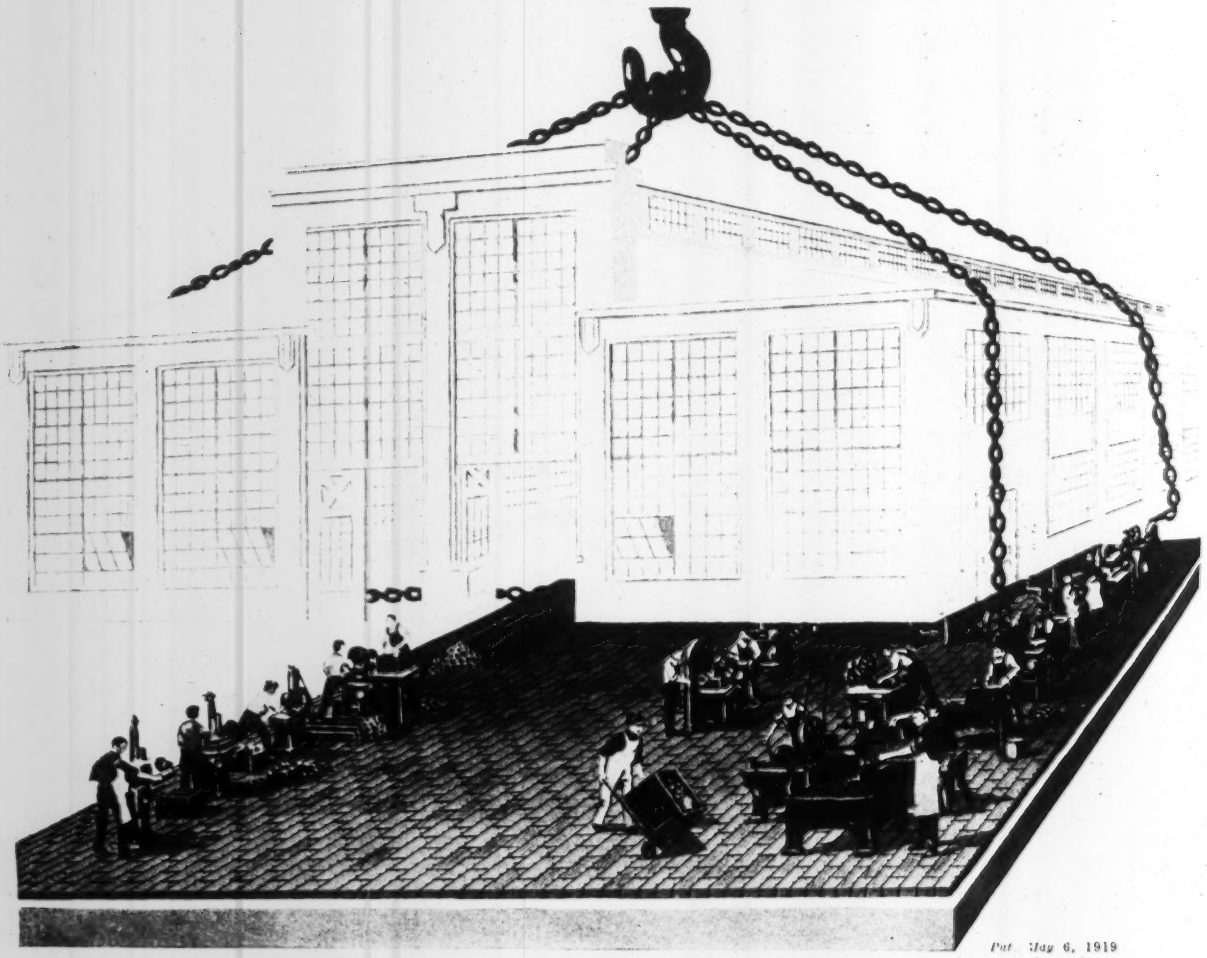
Operation and Tuning of the Cleveland Filters; *J. W. Ellms.*
Removal of Carbon Dioxide, Odor and Iron from Water at Virginia Beach, Virginia.
Operation Control Panels for the Sacramento, California, Filters

Supply and Distribution

How Devils Gate Flood Control Reservoir Replenishes Pasadena Water Supply.
A Table of the Large Water-Supply Reservoirs of the United States; *Allen Hazen.*
Making 30-inch Flexible Joint Cast-Iron Pipe; *W. G. Hammerstrom.*

KREOLITE WOOD BLOCK FLOORS

Outlast the Factory



Pat. May 6, 1919

The Floor is the PRODUCING Part

Remove the factory side walls and roof—you do not *stop* production—you simply *expose* it to the elements and outside distractions.

On the floor of the factory machines hum, men labor, products move along to completion. And the expedition and economy with which they move is governed entirely by the floor *assistance* or *resistance* encountered.

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Kreolite's patented process by which the blocks are impregnated with Kreolite Preservative Oil, makes them impervious to moisture from above and below. And its exclusive design provides grooves which, filled with Kreolite binder pitch, make the floor a single unit of such durability that it *outlasts the factory.*

Kreolite Wood Block floors are especially adapted for use in machine shops, foundries, paper mills, tanneries, loading platforms, and stables.

Our Factory Floor Engineers are ready at all times to co-operate fully, without obligation. Send for our service or write for our book on Kreolite Floors. Write the Toledo Office.

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

Volume 88 — NEW YORK, MAY 11, 1922 — Number 19

Our Water-Works Issue

THE American Water-Works Association meets next week in Philadelphia. In accordance with a time-honored custom of this journal and the two which it succeeds, this issue, as the one immediately preceding the convention, contains a larger and more varied list of articles on water-works and allied subjects than is ordinarily printed in a single issue. Both topically and geographically, the articles have a wide range, as is fitting in view of the wide scope of the association.

The Convention Program

THE program of the Philadelphia convention is well designed to attract, inform and inspire a large percentage of the membership of the association. It should do more. It should increase the membership. Half a hundred papers and committee reports are listed. That does not include the many topics suggested for the "informal get-together" group meetings. It leaves out of account the innumerable subjects on which individual members will gain both light for guidance and courage for action through the still less formal talks between old and new acquaintances and friends—among which the supply men will not be last or least.

Standardization

THE Standardization Council established two years ago and the sub-committees it announced at Cleveland last year are points of interest on the Philadelphia program. The council itself and a half dozen of its sub-committees are down for reports. As some of the relatively few subcommittees are hold overs—like the one on cast-iron pipe specifications—it would appear that either that "slow and sure" had been adopted as the motto of most of them or else that even a parental committee is not able to get much more life and action from numerous standing committees than when these committees were fatherless and motherless. But patience rather than hasty judgment is desirable.

Seventeen Committees

BESIDES the Council on Standardization there are associated with it no less than 17 sub-committees, with about 110 members in all—say 100 members, allowing for duplicate service. Although some of the committee titles disclose little if anything to standardize, all suggest opportunity for useful investigation and report. The parental or directing council affords a means of co-ordination, beginning with the choice of committee chairman and other members and continuing with advice as to the scope and methods of the committee work. Here again the prominence of matters of water quality and treatment are notable, seven committees with nearly 50 members appearing on the list. Judging from the number and character of its membership, the Committee on Colloid Chemistry and Its Relation to Water Purification has the most troublesome problems to solve. The committee, presumably will be one of research rather than standardization, at least for a time. Much seems to be likely to come of the other committees, as we have already indicated. Name and exact scope aside, the underlying idea of the council and its sub-committees promises added usefulness to the American Water Works Association. The hundred members who are co-operating to that end deserve commendation and support.

Water Quality and Treatment

THE fact that nearly half of the papers and committee reports have to do with some phase of the quality of water, its conservation and improvement, is significant. It is due primarily to the vital nature of the subjects indicated, which has led to the formation of various committees which are scheduled to report at Philadelphia, and which also caused the creation, some years ago, of a chemical and bacteriological section. Besides two sessions of its own, one of which will be devoted to the pressing questions of tastes and odors, the chemists and bacteriologists will provide the papers for a joint session with all the other members. The quality of water is most assuredly coming to the front.

The Engineer in Public Life

ENGINEERS have frequently been charged with neglecting their public responsibilities. When the results of an election or appointment are announced it generally happens that a lawyer, a merchant, a banker, a business man, or a politician is the man selected. Nevertheless, within the engineering profession there has been a growing appreciation of the desirability of more engineer representation in civic affairs. *Engineering News-Record* is endeavoring to discover what results have followed this change in attitude and has addressed to secretaries of national and local engineering societies requests for information on engineers who have been elected to some public office of a non-engineering character or who are otherwise taking an active part in public affairs. It is planned to publish a series of brief biographical sketches of these men in the news section and the first installment appears in this issue. Without the co-operation of our readers it is clear that this series cannot be made complete. It is requested, therefore, that you who read these lines send us the names of any engineers in your locality who are engaged in some form of public activity outside of regular professional duties. It is desired to limit the series to activities of a non-engineering character, so that a city engineer or a city manager, for example, irrespective of the value of their public service, would not qualify. What we would like to find out are the names of engineers who are mayors of cities, members of state legislatures, presidents of

chambers of commerce, aldermen, commissioners, or chairmen of committees engaged in civic or philanthropic works.

Our Largest Reservoirs

THE partial list of the largest storage reservoirs in the United States given elsewhere in this issue will surprise many because of its length and of the large capacity of so many of the reservoirs. A round dozen store 100 billion gallons or more of water that can be drawn off for *actual use*, while 35 store upwards of 50 billion gallons. Mr. Hazen, who compiled the list from data gathered by a committee of Engineering Council, recognizes that some large reservoirs may be omitted, while the gaps in the table afford evidence that for many of the reservoirs listed important figures are lacking, and also the uses which a large number of the reservoirs serve. Although compiled with care from the best available sources, Mr. Hazen states, some of the figures doubtless need revision. A service will be rendered the engineering profession and the conservation and use of one of the greatest of the natural resources of the country will be furthered by any and all who will assist in completing the list.

An Unobtrusive Strike

SINCE the beginning of the coal strike more than five weeks have elapsed. During that time the news of the strike has relinquished command of the first page and retired to a rear-rank position inside. The public has shown little interest. Indeed, the limiting factor in the production of those mines that are working is lack of demand rather than of capacity. Taking into account present production, possible increase under the spur of keener demand, and current drafts on consumers' stocks, another month probably will elapse before a shortage can be felt. Then will come the crisis in the current dispute. But further investigation has confirmed earlier diagnoses that the difficulties lie deeper than the issues now drawn and that the coal industry is seriously ill. Rumor has it that the President is to propose a solution of the problem. It is to be hoped that such a solution will be not merely balm for the present irritation but rather a thoroughgoing remedy that will attack the ailment at its source.

Do Designers Use Diagrams?

FOR some years this journal has discouraged the publication of diagrams for the design of reinforced-concrete beams. It has been observed that if a designer is of a certain type of mind he has some self-constructed curves which he insists on using to the exclusion of any other or if he is not diagram-minded, so to speak, he will not use any curves or tables whatsoever, no matter how cleverly they are constructed or how easily they can be used. Furthermore, if by any chance a concrete-beam diagram were published, the editors were immediately swamped with dozens of others of obvious superiority. Self defense alone indicated the aforementioned bar against designing diagrams. Of late, however, there has been a recrudescence of the concrete design curve and with them have come many authors who demand proof of the probable sorry fate of a diagram once published. They have been, some of them, quite insistent, so much so that we are led to make inquiry of concrete designers as follows: Do designers in general use diagrams for reinforced-concrete work; will they use those prepared by some one else; do they prefer comprehensive design tables or possibly simple tables plus extensive slide-rule work; is an all-embracing diagram preferable to a series of specialized curves?

Possibilities in Rural Engineering

RURAL engineering has come to mean a fairly definite thing. One bureau of the government at one time had the term in its name, and although the highway boom has now severed the titular tie, the work still goes on. Trade associations, too, dealing with engineering materials, have long recognized the market for their products on the farm and have devoted much of their professional literature thereto. There is, indeed, a society of agricultural engineers, with a publication and a fair-sized membership list. When all this is said, however, it remains that here is an attractive field that has not been properly tilled; there ought to be in our rural district openings for farm engineering practice which engineers, especially young engineers with the proper training and inclination, have been neglecting.

Farming and farmers need the engineer. No great amount of argument is required to prove that. From the problems of drainage and irrigation down to those of building design, house and barn sanitation, and machinery layout and selection, the overhead expenditures of the farm are all based on considerations essentially engineering in character. The farmer is the largest producer in the United States, yet even the casual observer in rural districts sees many examples of waste and loss resulting from the failure to apply the engineer's point of view in solving certain problems of farm operation and production. One might go even further and say that in large-scale farming under conditions common to the West the successful farmers are those who by natural bent or training use the engineer's method of approach in solving certain of their problems.

The difficulty is in persuading the farmer that he does need the engineer. He is, by hereditary usage and by environment, the most self-sufficient of men. Advice is the last thing he formerly paid for, especially if that advice was from what he considers a theoretical or non-practical source. More and more, though, the farmer is coming to look to outside sources of information. He is a great reader of farm papers. He consults machinery salesmen for type and size of equipment. He studies the government and trade-association bulletins. For such men the step to paid engineering service should be shorter than it would have been in the old days when the farm was isolated and the farmer too prone to depend on his own personal experience.

Here may be the opportunity for the engineer who is willing to study the field and accommodate himself to its peculiarities. A farm upbringing is almost a necessity; a wide acquaintance in and of the neighborhood is a requirement; a high and mighty detached air cannot succeed. The farm engineer must get down with his clients and work out their problems to the last detail, and a proper neglect of unnecessary theory should breed a respect that display of book learning or fancy practice would soon destroy. Land surveying might for a while at least be the backbone of such a practice and with it might come some business as township advisor on road, bridge and similar problems, for work with and for the farmer would develop slowly.

How Shall We Finance Our Highways?

ACCEPTED practice in highway financing runs strongly in the direction of short-term bond issues, and is based on the theory that the issues should be amortized in the "life" of the road. Now come the proponents of a theory, which starts from a basis fundamentally different and leads to the conclusion that 50-year bond issues are justified. These proponents, one of whom is Dr. Haig, who writes on the subject in this issue, lay down the premises that a road should never wear out. With their first stroke, therefore, they remove the whole basis of our present theorizing—namely, that roads *will* wear out, and that when worn out the bonds sold to construct them should have been paid off.

Obviously the advocates of the theory have had to write a new definition of "maintenance." They consider "maintenance" to include not merely the constant upkeep of surfacing but its rebuilding when necessary.

Under such maintenance a highway once built becomes a permanent improvement. It is then not unreasonable, say Dr. Haig and those who agree with him, to ask future generations to bear a share of the cost. In fact on purely theoretical grounds the bonds might never be amortized but each generation be asked to pay a rental on the improvement, in the shape of interest on a permanent bond issue. For practical reasons 50-year and not permanent bonds are advocated.

The advantages of the proposal are obvious. It would enable us to raise readily the sums necessary for extensive highway programs without unloading upon the present generation of general taxpayers, the heavy charge of amortizing highway securities in a 15 or 20-year period. The objections are that it increases the total cost of road improvement by spreading interest payments over a longer period of years and that it courts over-bonding. The larger interest charge, however, is probably more than offset by the savings in haulage due to earlier construction of improved roads.

The success of the theory in application would require the writing into the law of stringent requirements as to maintenance and a classification of re-surfacing as a maintenance charge. This accomplished, we believe that the issuance of 50-year bonds would be a defensible program, but, naturally, the total bonded indebtedness would have to be restricted to a definite proportion of the assessed valuation in order to keep within bounds of safe public financing.

As to the division of costs between the general taxpayer and the road user there will be, we believe, little dispute over Prof. Haig's suggestion. In fact, the same or closely similar proposals have been made before in engineering circles and have been well received. The vehicle user everywhere is willing to bear the maintenance cost, as usually understood, and will probably make no objection to the inclusion of re-surfacing as a maintenance charge. He will, we believe, also bear without protest the charges due to the excess cost incurred in building a highway up to the standards required by the motor. The proposal is reasonable.

All in all the theory as put together in Dr. Haig's article appeals to us as well considered. It raises question chiefly as to the advisability of piling up a large highway indebtedness. We instinctively dislike large public debts—and rightly so. Few of them leave tangible assets. What will the public temper be when the permanent asset in road improvements is proved?

The whole theory deserves careful consideration and discussion from the standpoint of each interest affected—and chiefly from that of the public.

Construction Equipment Accounting

EQUIPMENT performance studies, fortified by cost accounting for individual machines, have been developed to practical purpose in conducting force-account water main extension in Detroit. As related in this issue, these means have accomplished improvements in the design and fabrication of trenching and pipe laying machines, in the materials of which they are built, and in the accessories which they require for efficient operation. By their use some degree of standardization has been attained as, for example, specialization in gas-engine power. Even broad principles of equipment design and construction have been formulated in a tentative way.

The practice of the Detroit water department engineers throws light on a path to improvement in plant management which has not been adequately opened up by construction engineers and contractors. As an owner and operator of construction plant, the department has considered it to be its duty to advance equipment engineering knowledge and standards. This is an obligation which the contractor, the operator for profit of construction plant, has not been eager to assume.

Aside from the efforts of a few individuals, the aid which contracting has given equipment engineering has been incidental. The Detroit water department engineers on the contrary have consciously planned to learn where improvements were possible and have specified these improvements in making purchases. The difference is vital, for it is the difference between scientific determination and accidental discovery. This is the lesson which contracting needs to learn.

Perhaps the first thing observed in examining the work at Detroit is that knowledge has not been gained by considering equipment in mass. It has been gained by considering machines individually in all the events of their field and shop life. With a number of types and patterns of each kind of machine, as for example trench excavators, in service, the relative merits of differences in detail were thus made capable of determination. At the same time individual defects or merits grouped according to kind, for all machines, led to a possible enumeration of general principles. It is in this way that the Detroit studies have been utilized to show on one hand the specific fact that the box-girder boom is best for trench excavation and on the other hand the general truth that cast-steel cut gears are worth their extra cost for all kinds of equipment.

A virtue of this method of individual machine-accounting is that it is equally applicable by the large plant owner and by the small contractor with one unit of major equipment. With the different accounting methods sufficiently explained, the records of a dozen machines operated by as many contractors are nearly as useful for generalization as are the records of a dozen machines operated by one contractor. The situation would obviously be improved by the use of a uniform system of accounting and here contracting organizations have a service to perform. They need to press the importance of equipment accounting and to provide them with means for keeping uniform accounts.

Mechanical Equipment for Detroit Water Main Extension

Day-Labor Organization—Machine Selection and Operation—Shop and Job Accounting—Standardized Power Units—Cost and Performance Records

FORCE account construction of water mains in Detroit, Mich., has approximated a hundred miles a year for a number of years. In 1920, 130 miles of mains were constructed. These mains range in size from 4 in. to 4 ft., but the greater number are 6 and 8 in. in size. To carry on these considerable construction operations the city has organized and equipped its forces elaborately. Machines are provided for trenching, handling pipes and back-filling and for many special shop and field operations. Altogether a construction plant exceeding that of any contractor doing pipe-laying work has been assembled. This equipment is kept in repair and new equipment is built in well outfitted department shops.

Department Organization—A chart of the organization of the department of water supply, Fig. 1, indicates clearly the leading place held by the division of distribution under which comes practically all engineering and construction except that occupied in developing the filtration works, which are not yet completed. The bureau of construction and of power machines and the bureau of repair, with its sections of shops and yards, are chiefly the ones which enter into the present consideration of force account water-main extension. Incidentally all water-main extension is not carried out by the department forces. During the last few years contract work has averaged probably 15 per cent of the total.

In general the organization for pipe-laying is simple. Each field operation is in charge of a foreman who receives his orders, and is furnished with his machine equipment and materials through the construction bureau in conjunction with the bureau of power machines. The foremen report daily to the construction bureau and a summation of these reports comes daily to the Division of Distribution in the form indicated in Fig. 2. A report of similar form is received from the contract operations. A complete record of the day's operations and the location of operations for the succeeding day are provided by the daily construction report. Further operations of accounting, handling requisitions, allotting supplies and equipment, etc., are clerical details ordinary in character except, perhaps, for the exactitude required.

It is in the application of mechanical equipment to pipe-laying and the management of this equipment that the kernel of distinction lies in the department's direction of force-account construction. Machine construction is employed whenever it is practicable. Pavement breaking, trench excavation, pumping, pipe handling and backfilling are performed by machines. So are supplementary operations such as stone crushing, concrete mixing, providing compressed air, pipe-cutting

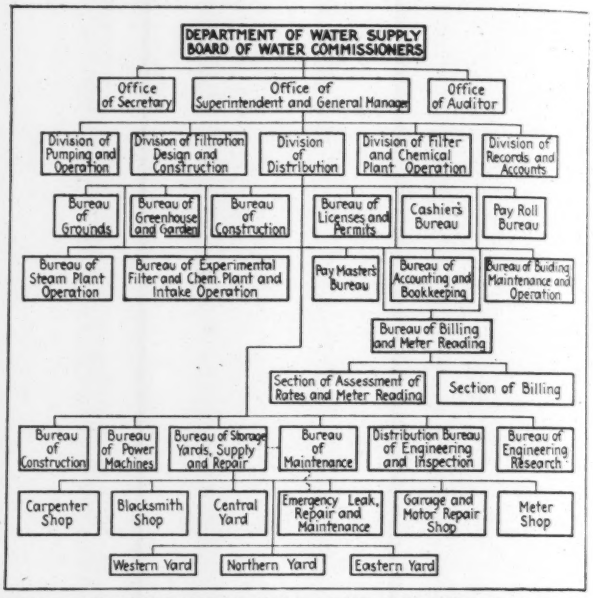

DEPARTMENT OF WATER SUPPLY
BOARD OF WATER COMMISSIONERS
Office of Secretary
Office of Superintendent and General Manager
Office of Auditor
Division of Pumping and Operation
Division of Filtration Design and Construction
Division of Distribution
Division of Filter and Chemical Plant Operation
Division of Records and Accounts
Bureau of Grounds
Bureau of Greenhouse and Garden
Bureau of Construction
Bureau of Licenses and Permits
Cashier's Bureau
Pay Roll Bureau
Bureau of Steam Plant Operation
Bureau of Experimental Filter and Chem. Plant and Intake Operation
Pay Master's Bureau
Bureau of Accounting and Bookkeeping
Bureau of Building Maintenance and Operation
Bureau of Billing and Meter Reading
Section of Assessment of Rates and Meter Reading
Section of Billing
Bureau of Construction
Bureau of Power Machines
Bureau of Storage Yards, Supply and Repair
Bureau of Maintenance
Distribution Bureau of Engineering and Inspection
Bureau of Engineering Research
Carpenter Shop
Blacksmith Shop
Central Yard
Emergency Leak, Repair and Maintenance
Garage and Motor Repair Shop
Meter Shop
Western Yard
Northern Yard
Eastern Yard

FIG. 1. ORGANIZATION CHART DEPARTMENT OF WATER SUPPLY, DETROIT, MICH.

and generating current for lighting the job. All machines are mobile, either self-propelling or mounted on wheels for hauling. In a large degree the power units are standardized. The machines are largely especially built or assembled to designs of the department engineers, or, where the standard designs of the manufacturers are employed, are altered in detail as by substituting steel for iron or cut gears for cast gears.

Pipe-Laying Equipment—Trench exacavation is the

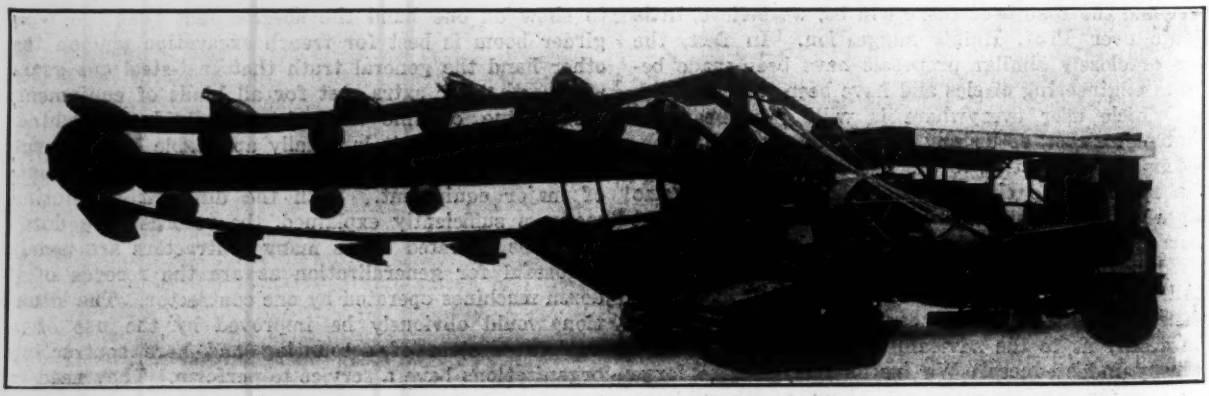


FIG. 3. CHAIN-BUCKET TRENCH EXCAVATOR
Latest type with box-boom, cut gears, multiple-cylinder gas engine, belt drive, screw hoist and oscillating crawler traction

THE BOARD OF WATER COMMISSIONERS OF THE CITY OF DETROIT

DAILY CONSTRUCTION REPORT

June 16th, 1921.

Laying Pipe

	Frederick E. John R.	A-1195		8					3													Frederick E. John R.	
	Theodore E. John R.	A-1196	200	8	H100	H 50	17	6			5		6		1 Trk.				37	4	41	Theodore E. John R.	

FIG. 2. DAILY CONSTRUCTION REPORT FORM

Original 16 x 14 in. filled out form, covering previous day's work, which is delivered to the construction division heads each morning.

big task of all pipelaying operations. In Detroit, the soil, generally a compact clay, lends itself well to machine trenching and a fleet of 10 trench excavators is operated. These machines date from 1917 to 1921, and, therefore include several styles. Except two wheel excavators, they are all of one make and of the chain bucket type. All, except one steam machine, are operated by multiple-cylinder gas engines. Trenches from 28 to 72 in. wide and from 8½ to 14 ft. deep are dug. Experience with these excavators indicates the following:

1. In Detroit soil, generally, as stated, a compact fine-grained clay, wheel machines give excellent service, but their use is limited by the shallow depth they can dig. The two Detroit machines dig 8½ ft. deep and are, it is believed, the deepest digging wheel excavators ever built.

2. In chain-bucket machines a box-girder boom, Fig. 3, is superior to the older double-channel type of boom. It is much stiffer and less likely to be distorted and to become loose.

3. Between screw hoists and cable hoists for the boom, the comparison may be stated as follows: With cable hoist, dependence is placed on the weight alone of the boom to force the buckets into the soil and in hard ground or frozen soil the digging cannot be crowded because the boom will lift. Where boulders or crossing pipes are encountered the cable hoist has the advantage that the boom will lift and ride over the obstruction. The screw hoist holds the boom down to the work and permits crowding in hard ground.

4. Gas-engine power is preferable to steam. The one steam machine, with a horizontal boiler, gives trouble due to the surging of the water which packs the frame unduly. A vertical boiler would be preferable. In any case, with steam machines the water haul is expensive unless a supply close to the machine is available.

5. The small sizes of chain-bucket machines lack frame rigidity and sufficient tread area to the crawler tractions.

6. Automobile type radiators, with fans, are superior to cooling tanks for gas-engine operated excavators.

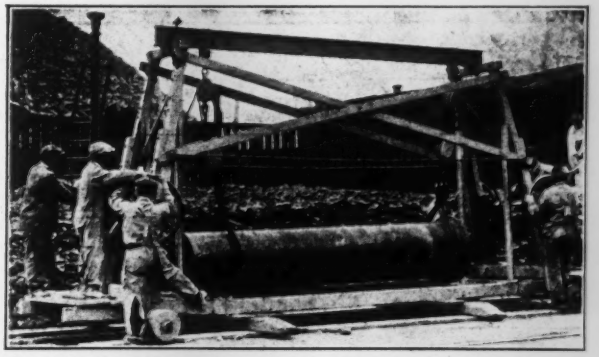


FIG. 4. PIPE-HANDLING GANTRY ON ROLLERS

Only pipe up to 30 in. is handled by these devices. For 36-in. to 48-in. pipe, valves and specials, locomotive cranes are altogether preferable.

7. Machine-cut gears add little to the cost and considerably increase the life of the excavator.

8. In crawler tractions, the oscillating type is superior to the rigid type because it reduces rack and tear of the machine.

Averages of trench excavation output, of the cost per foot of trench and of gasoline consumption do not signify much as these machines have to be operated to meet the conditions of pipe extension work. The jobs are numerous, only such output of trench is attempted as will keep the pipelaying steadily in progress, and the machines are of different styles, sizes and ages.

For handling large pipe, 36-in. to 48-in., locomotive cranes on crawler tractions have been found preferable to other machines. Three of these cranes are 3½-ton capacity for handling 36-in. pipe

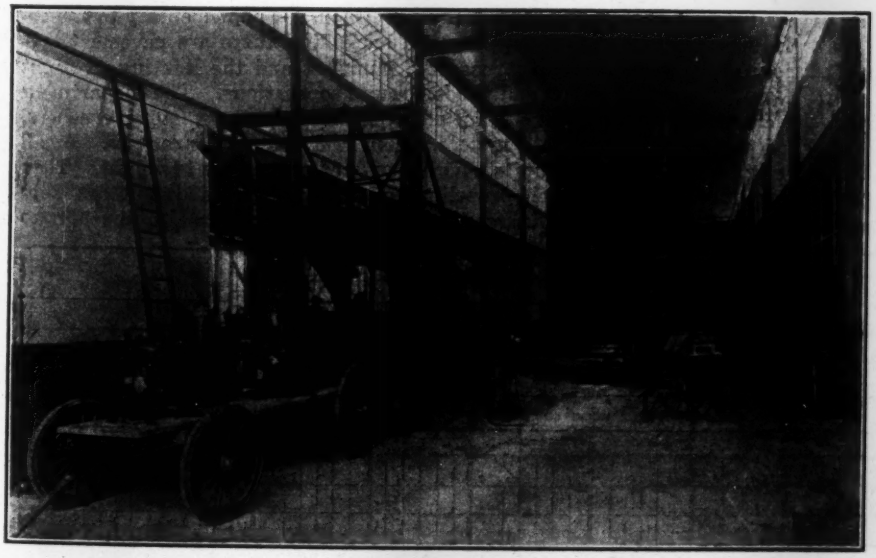
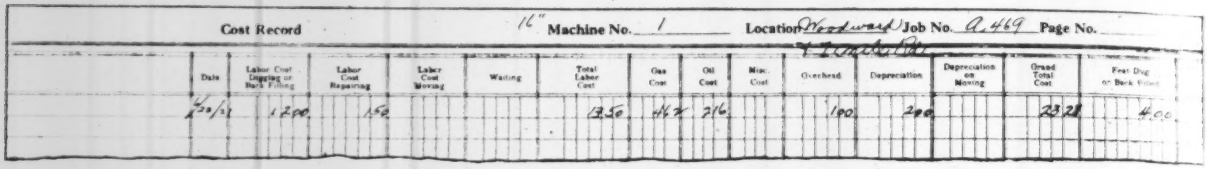


FIG. 5. ASSEMBLING BAY OF MACHINE SHOP

Pavement cutter, pumping outfit, locomotive cranes being assembled or in process of repair indicates types of machines.

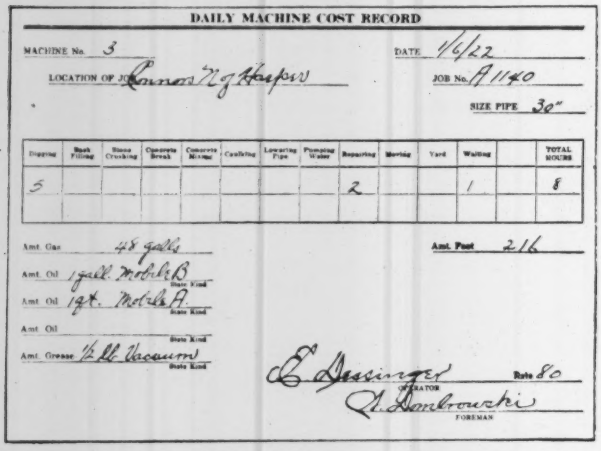

Cost Record 16" Machine No. 1 Location Woodward Job No. A.469 Page No.

Date	Labor Cost Digging or Back Filling	Labor Cost Repairing	Labor Cost Moving	Waiting	Total Labor Cost	Gas Cost	Oil Cost	Misc. Cost	Overhead	Depreciation	Depreciation on Moving	Grand Total Cost	Feet Dug or Back Filled
4/20/21	12.00	1.52			13.50	4.67	2.16		1.00	2.00		23.28	4.00

FIG. 6. SUMMATION COST RECORD OF INDIVIDUAL MACHINES
Original 16 x 14 in. Includes all costs except materials which are entered on a separate ledger sheet.

and a fourth is a revolving steam shovel converted by removing the dipper and adding a block and hook. The converted shovel has a capacity of 5 tons and is employed to handle 42-in. and 48-in. pipe. The converted shovel and one crane have steam power and the two others are operated by gasoline engines.

These cranes are particularly interesting for their illustration of the practice of the department engineers in extending the usefulness and improving the construction of purchased equipment. As the result of experience with the first 3½-ton gasoline crane, which


DAILY MACHINE COST RECORD

MACHINE No. 3 DATE 4/6/22

LOCATION OF JOB Cannon Mg Harper JOB No. A 1140

SIZE PIPE 30"

Digging	Back Filling	Stone Crushing	Concrete Break	Concrete Mixing	Caulking	Lowering Pipe	Pumping Water	Repairing	Moving	Yard	Waiting		TOTAL HOURS
5								2			1		8

Amt. Gas 48 gals Amt. Post 216

Amt. Oil 1 gall. Mobile B (Name Kind)

Amt. Oil 1 qt. Mobile A (Name Kind)

Amt. Oil (Name Kind)

Amt. Grease ½ lb Vacuum (Name Kind)

E Dassinger (Operator) Rate 80

A Dombrowski (Foreman)

FIG. 7. DAILY MACHINE COST RECORD

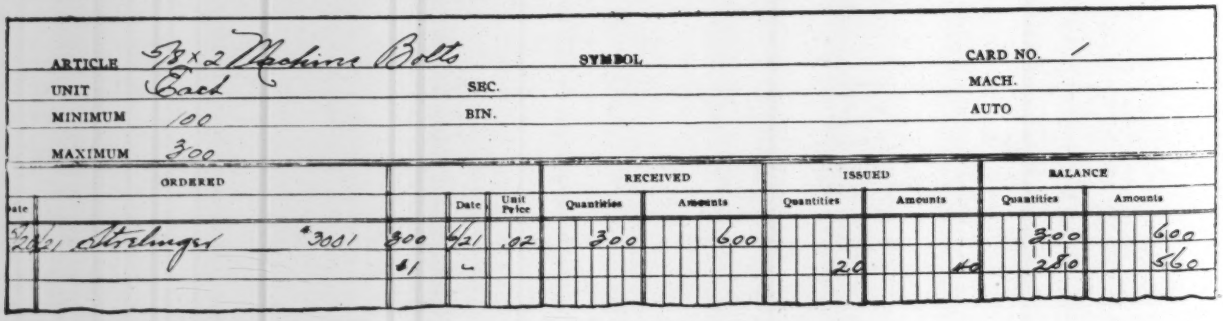
had a Buffalo engine and cast gears, the second 3½-ton crane was ordered equipped with an "Automatic" engine and built with machine-cut gears at an extra cost of $1,600. The experience of the department has been that the added cost of cut-steel gears is returned in longer life and less maintenance of almost any large and expensive piece of equipment.

In the case of the converted shovel the crawler traction treads which were wood blocks shod with steel, and had proved short-lived, were rebuilt, at the department shops, of cast steel. The cost was reduced and the life increased. This sort of reconstruction is regular practice, wherever weakness develops in purchased equipment. Additional outfit is also regularly installed wherever the machine can supply a supplementary service in connection with its major purpose. The two steam cranes are outfitted, for example, with vertical locomotive type air compressors and air receivers. These compressors give 90 cu.ft. of free air per minute for pipe caulking and other uses without bringing in a special compressor outfit and an additional operator. Practically all steam machines are outfitted with air pumps.

For more extensive uses of compressed air there are portable compressor outfits. These are hauled by motor trucks. The latest style has a four-cylinder automobile-type engine and has proved easier to keep in repair, and to put in operation and it causes less vibration than the older two-cylinder horizontal gas-engine outfits. Here it is noted that for all but small-size gas motors, the department has standardized on automobile-type engines. For small units standardization consists in using one make of engine. This uniformity has saved greatly in the expense of stocking repair parts and making repairs and replacements.

For smaller pipe handling operations, ordinary hand processes or gantry and winch outfits as indicated in Fig. 4, have been used. Backfilling, however, is again usually a machine process. Practice has settled definitely on boom machines with crawler tractions and two-cylinder gasoline engines of 12 to 15 hp. These heavier machines are more efficient, where the spoil bank is partly frozen or has set after long exposure. Maintenance on backfillers, in proportion to their cost, runs higher than on trench excavators and other equipment generally, which indicates the need of more sturdy manufacture.

Supplementary Equipment.—Supplementary to trenching, pipelaying and backfilling there are pavement cutting and repaving, pumping and the lighting of night work and underground operations. The department equipment includes pavement cutters, stone crushers, concrete mixers, pump and compressor outfits. In all these units a high degree of portability is sought. They are self-propelling or carriage-mounted and are kept down to reasonably small size. It is also the aim to


ARTICLE ⅝ x 2 Machine Bolts SYMBOL CARD NO. 1

UNIT Each SEC. MACH.

MINIMUM 100 BIN. AUTO

MAXIMUM 300

Date	ORDERED			RECEIVED Date	Unit Price	RECEIVED Quantities	RECEIVED Amounts	ISSUED Quantities	ISSUED Amounts	BALANCE Quantities	BALANCE Amounts
3/26/21	Stockroom	3051	300	4/21	.02	300	6.00			300	6.00
			61	—				20	.40	280	5.60

FIG. 8. PERPETUAL INVENTORY FORM
All machine supplies, replacement parts and repair materials are recorded on these blanks.

standardize on one-cylinder Novo engines or four-cylinder automobile type engines. So far as possible one-man operation is attained. These characteristics all fit in with the service of the machines, which is scattered and is not of long duration in any place.

Shops and Yard Service.—The success of force-account work with intensive use of labor-saving machines depends largely on perfect yard and shop service. In Detroit, materials and supplies are stored at three yards, as indicated by the organization chart, Fig. 1, which also indicates a projected future yard. At one of these yards are the machine shops. All have railway sidings, track-scales, and 15 or 20-ton locomotive cranes for unloading cars. The larger cranes will handle a 48 x 48-in. Y-casting which is about the heaviest piece used. Delivery from the yards to the work is by motor trucks; the department has standardized on 3-ton and 6-ton Packards.

Is is in its shop development, however, that the department's practice is more particularly distinctive. The shop is new, Fig. 5. It is large enough and well enough equipped with forges, hammers and machine tools to fabricate any part of any machine employed and to assemble at the same time several of the larger machines. This statement is important to bear in mind. The shops and their equipment are not the ordinary city department shops for making minor repairs and replacements; they are outfitted to fabricate construction machine parts or even complete machines capable of being produced from standard structural shapes, castings and forgings. Besides repairing equipment they produce, between repair jobs, various small forgings, etc., required by the department.

Precise shop records are kept on every piece of equipment. The items recorded include repair parts, supplies, shop labor, field labor operating the equipment, and daily output. For this purpose there is a complete system or order blanks, shop and field report blanks, ledger summation sheets, etc. A number of these, the extension of whose use to other cost recording systems is possible, are shown by Figs. 6, 7 and 8. The noteworthy idea is that there are a daily field cost record, Fig. 7, a repair part shop record and a summation cost record, Fig. 6, for every machine. This indicates a principal of equipment cost keeping which permits exact analysis of the service which every machine and every part of that machine gives in terms of useful work done. It is these studies which are enabling the department to standardize on types and sizes and to specify special construction of parts prone to wear or breakage.

Bascule Bridge Introduced in China

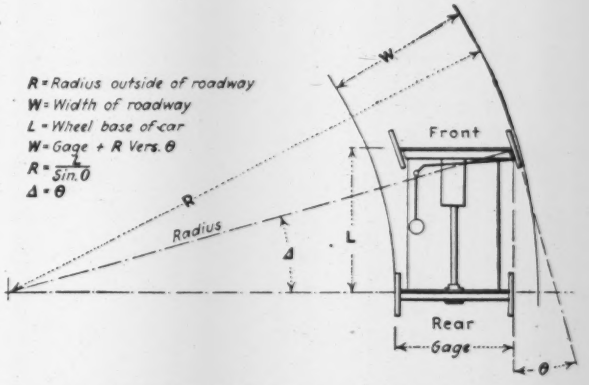
It is reported that the first bascule bridge in China is to be built over the Grand Canal in Tientsin in the near future. The bridge, which will have pagoda-like towers and ornaments typical of Chinese architecture, has been designed by the Strauss Bascule Bridge Co. of Chicago, and will have a total length of 280 ft. between abutments. It consists of a vertical-overhead-counterweight double-leaf span of 130 ft. flanked on each side by fixed spans of 75 ft. The traffic on the Grand Canal at Tientsin (or Pei Ho as it is known at this point) is very dense and the bascule type of bridge was decided upon in order to facilitate the movement of river traffic at this point.—*Journal of the Association of Chinese and American Engineers*, Peking, December, 1921.

Should Highway Curves Contain Transition Spirals?

By Ernest L. Culbreth
Former Instructor in School of Engineering, Mississippi A. & M. College

From recently-published data on highway design the writer has found that most authorities reviewed have recommended simple or compound circular arcs for all roadway curves—an hypothesis that may be premature. It appears that the duty of the highway engineer is first to determine the nature and effect of the operation of vehicles upon highways and then, with consideration for safety and economy, recommend the design that most nearly satisfies the requirements. Following this thought, the present and growing popularity of automotive vehicles demands that the highways be designed entirely for their use; therefore study of the operations of automobiles is necessary in order to design properly.

In a recent design with which I am familiar the requirements permitted only curves of short radii.



PLAN FOR DETERMINING HIGHWAY CURVE FUNCTIONS

These curves were made simple circular arcs. The roadways were, of necessity, narrow. It was a great surprise to find that automobiles did not follow these arcs but formed curves sharp at the center and flattening into straight lines at the tangents or at points of reverse curvature. Upon investigation the tracks were found to form spiral transitional curves. I have measured a number of automobile tracks and, finding them to be spirals, have sought the reason in the mechanical operation of the vehicles.

In the sketch herewith the angle θ is the angle formed by the front wheels of an automobile and the chassis and is equal to the central angle Δ. Then it may be seen that when θ is increased from 0 to any value by the will of the driver, angle Δ will change with it and at all times be equal to it. The radius R of the curve at any position equals sin θ divided by the wheelbase of the car. θ is a variable and so is R. The wheelbase is constant for any given car.

In view of these facts it can readily be seen that the driver would be compelled to stop on the tangent at the point of curvature and turn the steering wheel enough to orient the car on the same radius as the curve were he to follow circular arcs. After he had driven around the curve he would have to stop and orient it on the forward tangent. However, in practice the driver on approaching a curve simply continues to turn the steer-

ing wheel till the car is oriented on the curve and reverses the operation at the forward tangent. Thus angle θ is a variable, increasing from 0 on the first tangent to the value required for the circular arc, and decreasing at the end of this arc to 0 on the forward tangent. It is clear that the increase and decrease of angle θ is regular, therefore the curve formed is a transition spiral.

A good reason why highway curves should be joined to tangents by spirals is, that to prevent unequal distribution of the weight of the car on the wheels, lateral skidding and possible overturning as a result of the centrifugal force acquired, it is necessary to superelevate the outside of the roadway on a curve. To prevent torsion in the chassis and shock to passengers this superelevation should be obtained by regularity of increase from the tangent to the required value at the circular arc of the curve.

From about fifty actual tracks measured, it was found that short curves having a central angle of 90 deg. or less were simply two spirals having a common tangent at the middle. Those having a larger central angle, and long curves generally, contained a circular arc in the middle and differed from the typical railroad curve only in the length of spiral which was found to be much shorter and of nearer constant length. The speed of the cars making a number of the tracks measured could not be ascertained.

The spiral length that appears to meet the demands of the driver differs from the following railroad spiral length

$$L = \frac{2D}{\left(\frac{60}{V}\right)^3}$$

and from the highway curves measured we get an approximate formula something like this:

$$L = \frac{3D}{\left(\frac{60}{V}\right)^3 \sqrt{2D}}$$

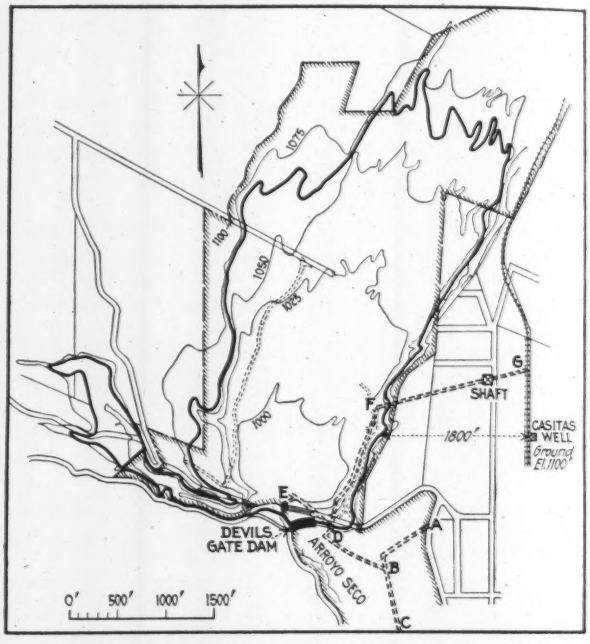
in which L equals length of spiral in 100-ft. stations, D the degree of curve of circular arc, and V the velocity of the machine in miles per hour. Having found the length we may proceed as in railway work.

For any point the width of required roadway is equal to the gage of the car plus the wheel base multiplied by the sin θ. Due to the dragging action of the car this extra width should in all cases be on the inside of the curve.

Flood-Control Dam Replenishes Underground Water Source

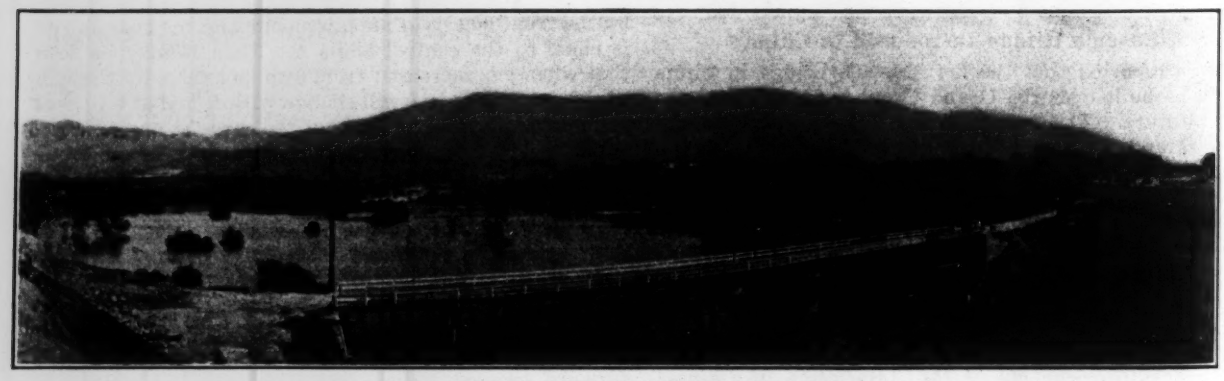
Results of Two Seasons' Experience with Devil's Gate Dam at Pasadena—Flood and Water Storage Functions Conflict

DEVIL'S GATE DAM, completed in September 1920, in the Arroyo Seco near Pasadena, Cal., was built by the Los Angeles County flood-control district as a control measure. To serve its primary function, the reservoir is being kept empty, or nearly so, during the season of the year when heavy runoff occurs. This, unfortunately, keeps down the water level in the reservoir at a time when water is available for distribution into the gravel beds adjoining. However, on the occasions when the reservoir has held large volumes of water there has been opportunity to observe the effect on these underground gravel beds. The con-



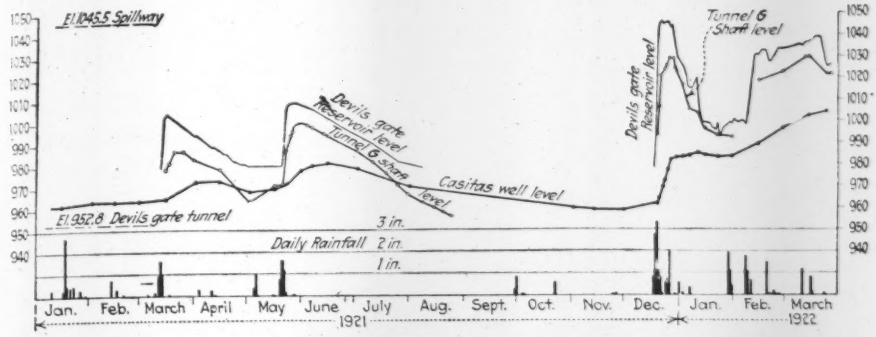
WATER INFILTRATION GALLERIES NEAR RESERVOIR

The galleries or tunnels indicated by letters A to G are on a 1 to 1,000 grade, 165 ft. below the mesa surface at their upper ends. To increase their yield a submerged dam was built some years ago below the end of tunnel E and just above the present Devil's Gate dam.



RESERVOIR FORMED BY DEVIL'S GATE DAM

Porous bank at right through which water passes to tunnels. Old bridge to be removed.


El 1045.5 Spillway
Devils gate Reservoir level
Tunnel G Shaft level
Casitas well level
El 952.8 Devils gate tunnel
3 in.
Daily Rainfall 2 in.
1 in.
Jan. Feb. March April May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. March
1921
1922

RELATION OF WATER LEVELS IN RESERVOIR TUNNEL G AND CASITAS WELL

The water levels in the tunnel and wells fluctuate with the depth of water in the reservoir.

clusions are that accumulations of water in the reservoir are of direct and very material benefit in replenishing and sustaining the dry season's supply in the underground sources.

The dam is an arched structure 120 ft. high, located in a narrow gorge where the stream passes through a gap in a granite spur extending from the range of hills on the west into the alluvial mesa on the east. The construction of the dam was described in *Engineering News-Record*, July 29, 1920, p. 202. The drainage basin includes an area of 30.5 sq.mi. of which only 3.5 sq.mi. are table land or mesa and the remainder is in the precipitous Sierra Madre. During the flood of 1914 the Arroyo Seco carried a maximum flow of 11,400 sec.-ft. The highest flow since the completion of the dam occurred in December, 1921, and carried about 2,300 sec.-ft. or 21 per cent of the 1914 flood. The reservoir has a capacity of 4,600 acre-ft., covering 154 acres at spillway level.

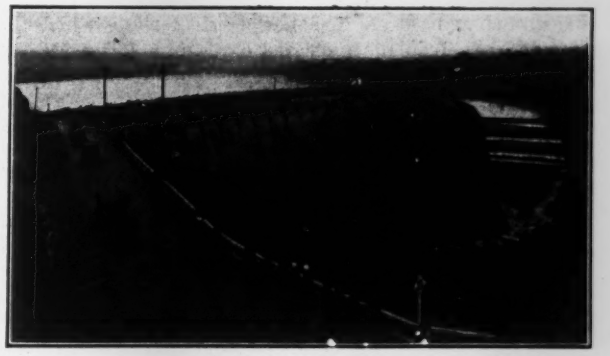
For a considerable distance along the east rim of the Arroyo above the dam the mesa has an average height of 40 ft. above the stream bed and slopes gently away from the Arroyo to the south and east. This mesa is the debris cone consisting largely of porous material which was formed by the stream flow from the same watershed. After the formation of the cone the present channel of the stream was apparently cut through to a lower level. Water from the present channel seeps rapidly into the porous material and percolates in a southeasterly direction, supplying the underground storage known as the Pasadena water basin from which many pumping plants extract water for Pasadena, South Pasadena, Alhambra and San Gabriel.

In the mesa close to the southeast corner of the present reservoir the city of Pasadena some years ago constructed about a mile of water infiltration tunnels or galleries to collect seepage water from the basin and convey it to points where it could be used conveniently. These tunnels (see map) are 4 x 6 ft. in cross-section and are lined with concrete except in the portions through solid rock. Water seeping into the tunnels is retained by concrete bulkheads at their lower ends, into which pipes are tapped and from which the flow is controlled by valves.

On March 14, 1921, after a heavy rain, water collected in the reservoir to a maximum depth of 48 ft. At that time 600 acre-ft. of water was estimated to have been in the reservoir. On March 15 the water subsided about a foot. It continued to subside for the next ten or twelve days at about the same rate, passing entirely into the adjoining gravel beds and mesa land tapped by the tunnels. A second rainstorm, May 21-24, stored about 825 acre-ft. of water in the reservoir in addition to the amount collected in the previous runoff. This second accumulation brought the height of the water to 52 ft. on May 27.

The rains of last December caused a runoff exceeding any that had occurred since the completion of the dam and afforded a practical demonstration of its flood protective value, as well as an opportunity to observe the effect on the underground water storage.

An accurate record of the amount of water flowing from the collecting tunnels and particularly the water level in Casitas Well, and in the shaft in tunnel G, kept by S. B. Morris, chief engineer of the Pasadena Water Department, shows a very definite relation between the reservoir water level and the rate of percolation. The history of rainfall, reservoir level and percolation is given in the accompanying chart prepared by Mr. Morris.



DEVIL'S GATE DAM WITH RESERVOIR FULL

Built for flood control. While serving this function the reservoir increases Pasadena's underground water supply.

The rate of percolation has been found to be greatest when the water is at maximum height in the reservoir and to vary in inverse proportion to the water level, i. e., the rate of percolation is much slower as the head diminishes. The loss due to evaporation is considered negligible at the time of year when the floods occur.

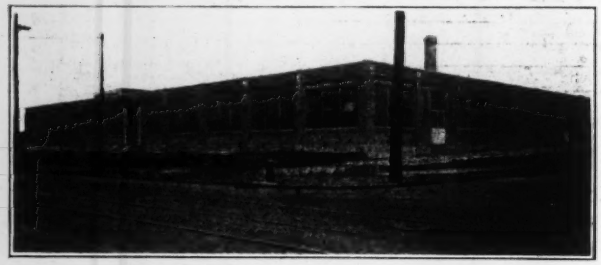
The arrival of any substantial flood in the reservoir causes an almost immediate effect in the collecting tunnels. After the floods of March 13-14 and May 21-24, the use of water from the Pasadena water tunnels had to be discontinued for five days because for that period the turbidity was too high for domestic use. Bacterial counts, Mr. Morris states, show that the water passes through the banks of the reservoir with very little effect of filtration, the bacterial count going as high as 2,000 per c.c., immediately following floods in times when the normal count with no water in the reservoir is about 5 to 10 per c.c.

Central Repair Shop for Philadelphia Water-Works

Units Heretofore Scattered Over City Brought Together—Machine, Blacksmith, Tinsmith, Carpenter, Pattern, Foundry and Auto-Repair Departments—Maintenance Headquarters and Storage Shed Adjacent

BY JOHN M. BROGGINI
Chief Draftsman, Bureau of Water, Philadelphia, Pa.

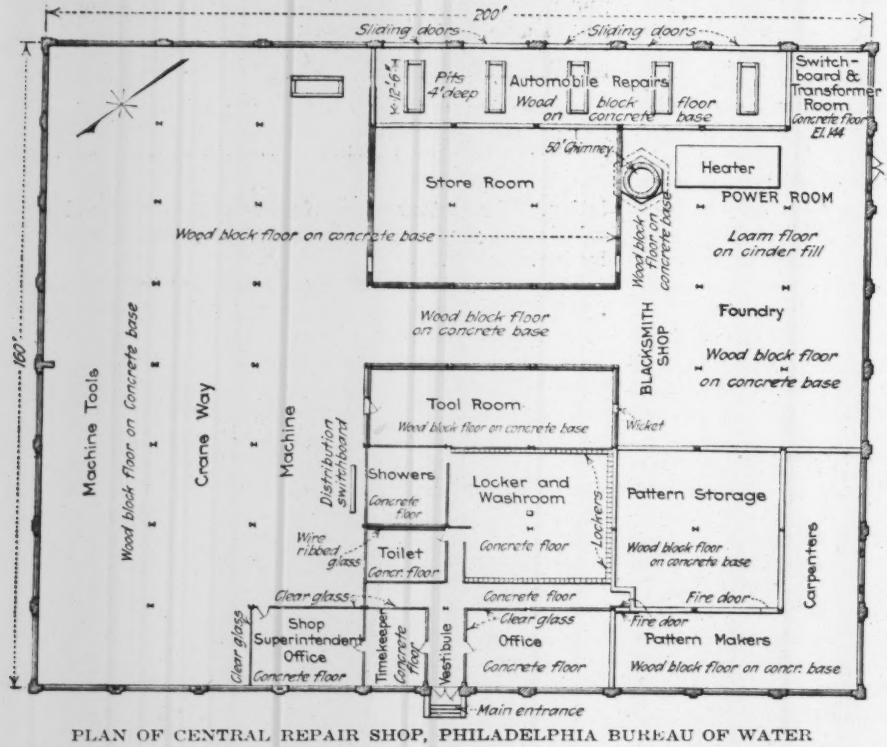
ONE general repair shop just completed for the Philadelphia Bureau of Water was decided upon because the large repair equipment otherwise needed at many plants would be almost prohibitive in initial cost and maintenance. Heretofore the units that now comprise the general repair shop were not only inadequate but were so located as to make the various steps necessary for hauling, repairing, etc., a serious problem. The routing of orders through many hands was necessary. With a single shop the overhead will be cut to a minimum and will be far more direct and efficient than before. The new central shop, which is 160 x 200 ft. in plan, is located close by a 100 x 280-ft. headquarters building and a storage shed 40 x 230 ft. in plan, both of which are now under contract. The group will make a compact maintenance unit. This article will be confined to the new shop.



FRONT VIEW OF GENERAL REPAIR SHOPS

The building is of strictly fireproof construction—brick and steel with terra cotta trimming. For the safety of the materials stored, a sprinkler system was installed in the carpenter shop, pattern storage and automobile repair shop. As the building has a ground floor only it covers an area of 32,000 sq.ft. Due to the large roof area the deck material was carefully considered as it was desirable to keep the steel tonnage as low as possible and still have a permanent and fireproof construction. Gypsum roof tile was used, which besides being light and fireproof is an efficient insulator.

The repair shop is subdivided into the following departments: Machine, blacksmith, tinsmith, carpenter, pattern, auto repair and foundry. The convenience of the layout may be seen in the accompanying plan. As access to any part of the shop by truck is through two gates only, all deliveries are controlled from the clerk's office, located just inside the main entrance. Delivery of heavy materials is facilitated by the trucks being able to drive under the crane runway which is equipped with a 10-ton three-motor electric traveling crane. To facilitate heavy deliveries, the machine tools are grouped according to their operation—lathes in the turning group, planers in the planing group—particular care being taken that the large machines of each group were placed under the craneway so that heavy work could be handled with ease.



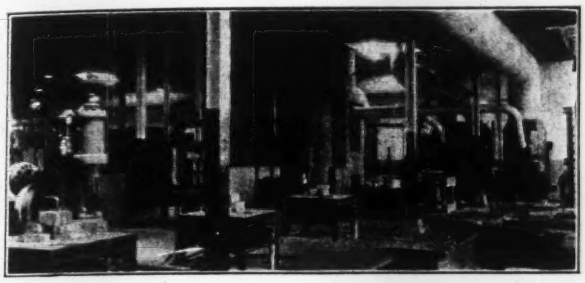
PLAN OF CENTRAL REPAIR SHOP, PHILADELPHIA BUREAU OF WATER
A one-story building 160 x 200 ft. in plan concentrates the repairs for a water-works system of many units serving a large area.

Consideration was given individual drive in cases where the machines were large, and daily use probable. Group drive was selected in the majority of cases, but with division into small groups, as, unlike a production shop, the kind and quantity of work is more or less uncertain. Motors were used in both individual and group drives. One very noticeable feature of the shafting layout is that no wood footing pieces are used. The hangers are bolted directly to the channel stringers, with adjustment bearing set screws.

The blacksmith equipment at the other end of the building consists of an 100-lb. and a 600-lb. electric-driven hammer, four 40-in. forges, one 50-in. forge and a billet furnace. The electric hammers were kept as far away as practicable from the foundry to prevent vibration of the molds.

The large forge, both hammers and the billet furnace are located near each other, a hand-operated jib crane being provided to lift material from one to the other.

The foundry is planned to take care of small casting work of which there is considerable. Equipment for large work seemed impracticable due to the uncertainty as to its being needed. A small core oven, pit



BLACKSMITH SHOP, WARM AIR FURNACES IN REAR

crucible furnace and two melting pots are provided. To handle the crucible from the furnace to the moulding floor, a monorail hand-operated hoist and crane, supported overhead on beams connected to building columns and pilasters, was installed.

The forges, furnaces, core oven and melting pots are all oil fired by a low-pressure system. The oil is stored in a 12,000-gal. tank in a pit outside the building. A pump lifts the oil to an auxiliary tank of 250-gal. capacity provided with a float switch which automatically controls the supply to the units. In view of the fact that heavy crude oil of 16 to 14 deg. Baumé is to be used, steam lines and coils were placed inside the oil lines and in both tanks, thus insuring a greater reliability of operation. Air is supplied through galvanized-iron piping by a direct-connected motor-driven fan blower. All oil and air lines were run in underground concrete ducts covered over with plates. The system was designed for an oil pressure of 20-lb. per sq.in. and an air pressure of 12 oz. per sq.in. at the burners when operated at a maximum capacity.

Both store and tool rooms are centrally located in relation to all departments. They are equipped with modern steel racks and bins permitting the storing of a great variety of tools and spare parts, and with machines for their adjustment and care of the tools.

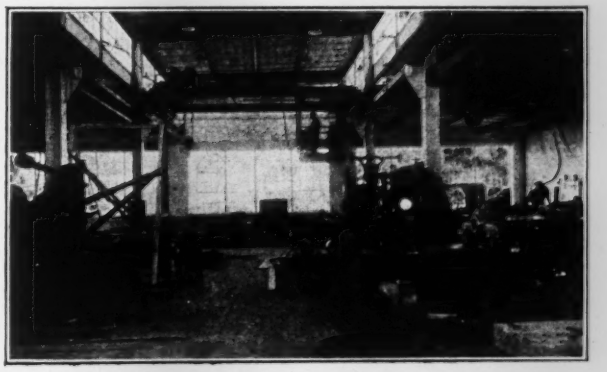
In the rear of the building is an automobile repair shop with five work pits for passenger machines and small trucks and one for large trucks. Access to this shop is through large sliding doors from the court. Automobiles may come in or leave any bay without disturbing others that are being repaired.

The carpenter shop and pattern storage room are separated from the remainder of the building by fire walls and doors. The wood-working machinery is such that the lumber to be used for the various purposes can be handled from the rough, thus permitting advantageous buying of market sizes.

The current for power and lighting is bought from a local electric company but a chimney of ample capacity has been provided so that a power plant can be installed at any time. Due to the numerous lines necessary, all conduits, except lighting circuits from the individual panel boxes, are concealed in the concrete subfloors. Receptacles for small electric hand tools are provided at frequent intervals. With the fact in view that on many occasions it would be necessary to work at night, the lighting was arranged in small circuits so that only one particular part around the machines needed could be lighted. In addition to the general lighting, each machine tool is equipped with an individual lamp for close work, which may be shifted to light any part of the machine.

In laying out the plumbing, a sanitary base was provided around all toilets, showers and washrooms, and the fixtures were placed in the center of their respective rooms, thus avoiding any contact with the walls and partitions. Light and ventilation is provided by the roof.

To heat this large building hot air was chosen. Heating with steam would have required 10,000 sq.ft. of cast-iron radiation, which, with all the other equipment, would have meant a very large expenditure. As the foundry is not separated from other parts of the shop, steam rising from the moulds when pouring off, as well as the smoke and noxious gases, were also to be considered. Although roof ventilation was provided, most of these gases are heavier than air and lie near the floor and are not affected by the roof vents. Further, instead of removing the steam, roof vents would only accelerate the annoyance from it, as the warm air which escapes must be supplanted by the outside air, and this not being properly heated chills the air within the building, thus reducing its capacity to carry moisture and causing greater precipitation. A blower warm air furnace heating system was decided on, with overhead galvanized-iron ducts as a means of distribution. The heated air is discharged where most needed. When ventilation is required this system affords a positive



LARGE MACHINE TOOLS CONVENIENT TO CRANE

means of accomplishing this particularly desirable result, which is independent of the changing climatic conditions.

The plant described in this article was designed under the direction of Carleton E. Davis, chief of the Bureau of Water.

Western Logging Companies Own Railroads

At the 1921 Pacific Logging Congress, the secretary's report contained the following figures as to the mileage of logging railroads and the kind and amount of railroad equipment employed by Western logging companies: logging trucks, 8,362; flat-cars, 4,039; steam shovels, 101; locomotive cranes, 62; geared locomotives, 725; direct connected locomotives, 240; logging railroad mileage, 5,240.

CO_2, Odor and Iron Removal at Virginia Beach, Va.

Water from Wells in Marsh Land Aerated, Treated with Milk of Lime and Chloride of Lime Settled and Filtered

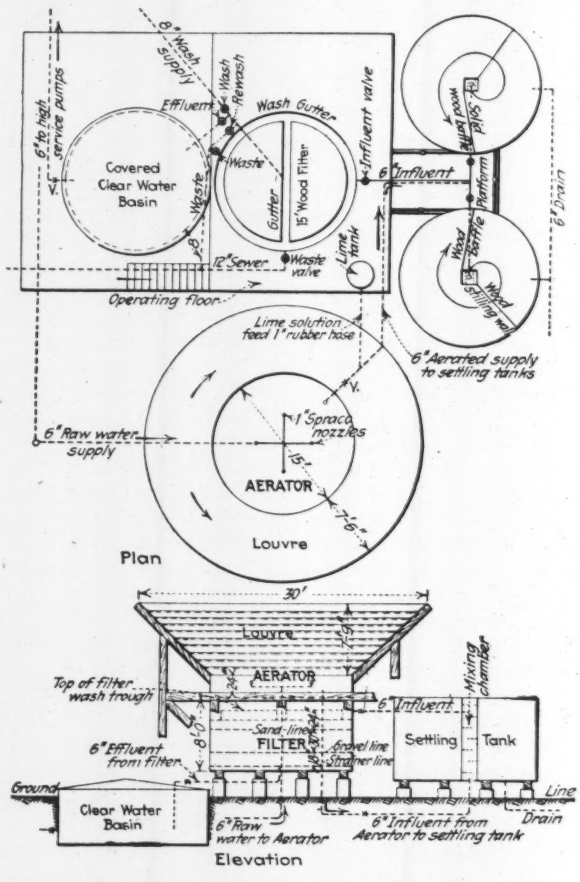
Official Summary of a Report by the Engineering Division of the Virginia State Board of Health—Richard Messer, Chief Engineer, A. Wagner and Linn H. Enslow, Assistant Engineers, Richmond, Va.

VIRGINIA BEACH, a sea-side summer resort on the Atlantic Shores of Virginia, is an incorporated town with a resident population of 900 and a transient population of 10,000 to 12,000 which is rapidly increasing year by year. Its water supply has always been its poorest asset in that it has been objectionable on account of odors and iron content. These objectionable qualities have apparently been on a continuous increase, being worse in summer than in winter, until during recent summers the water has been used only for bathing, sprinkling and automobile washing. Water for laundry and kitchen uses has been gathered by cisterns, while table water has been purchased from commercial water bottling establishments. The town having tried to remedy the situation in the past through treating the raw water with lime and then passing it through a pressure filter without success had abandoned the plan and was using the untreated raw water. The authorities were pursuaded by the Division of Engineering of the Virginia State Board of Health to build an aeration-filtration plant, assurance being given that considerable improvement to the supply would result. Construction was started in the spring of 1921 and the plant placed in operation in the summer of the same year. Because of the unusual CO_2, iron and odor content of the raw water used and the satisfactory plant efficiency obtained, it was thought that the following information might serve to clear the minds of many as to what may be expected during treatment of waters of similar quality.

Source and Character of Supply—The supply is taken from 31 driven wells in an old marsh area. These wells are 2 in. in diameter and 20 ft. deep, the strata penetrated being 12 ft. of clay, then a 2-in. layer of "hard pan" of high iron content and finally 8 ft. of fine white sand. During the past few years, the tap water has been impregnated with an intense odor caused by the decomposition of nitrogenous animal tissue in the pipe system. The odor was especially noticeable at hot water spigots. Frequent blowing off of mains was necessary. In brief, the water was unsatisfactory for laundry and culinary purposes. The town had been anxious for some time to obtain a satisfactory supply, but not until 1920 could a method of financing it be worked out.

After an investigation by this Division, including chemical analysis of the water at various points in the system, recommendations outlining a treatment plant were made to the authorities. The City of Norfolk was at the time replacing its wood-tub filter plant with concrete units. The Town of Virginia Beach was offered, free of charge, any parts of the discarded plant which might be suitable for the erection of the contemplated iron removal plant. This offer was accepted and the plant built.

Aerator and Chemical Treatment—From the wells the water is forced by a gasoline-engine-driven duplex pump through four "Spraco" nozzles inside of a shallow elevated tank, the nozzle pressure being 6 lb. Around the top of the tank is a louvre fence forming a "saucer" or "bowl" that catches the dropping spray and allows a circulation of air between the spacings in the fence. From the tank the aerated water descends by gravity to the mixing chambers within the settling tanks. A mixture of milk of lime and chloride of lime solution is fed by gravity near the entrance to the mixing chambers. The lime dose is regulated so as to remove the last traces of CO_2. A trace of phenolphthalein alkalinity (normal carbonate) is maintained in the settled water. Chloride of lime serves a triple rôle and a trace of available chlorine is maintained in the settled water. The chlorine serves as an oxidizer of any reducing compounds or ferrous iron that may escape oxidization during aeration. It oxidizes organic compounds, reducing odors and at the same time maintains a sterile water through the plant.



PLANT FOR REMOVING CO_2, ODOR AND IRON FROM WELL WATER AT VIRGINIA BEACH, VA.

Raw water passes through spray nozzle aerator where it receives lime treatment. Goes thence to mixing and settling tanks, then to filter and finally to covered clear water basin.

Mixing Chamber and Settling Tanks—At the center bottom of the two circular wooden settling tanks (in parallel) and extending to the flow line is a box mixing chamber. Treated water entering at the bottom passes upward around the horizontal baffles in the mixing box and is distributed at the water level in the tanks. A solid partition in the tank causes the flow to take a

course of 360 deg. to the opposite side of this baffle wall where it leaves to enter the filter tub. The distribution of flow is made uniform by a stilling wall of 1 x 10-in. boards with 1-in. spacing. The stilling wall is 120 deg. from the influent side of the baffle and 240 deg. from the effluent side. Though the water enters the tanks at the surface, because it is always colder than the water in the tanks it has a tendency to take a downward course, mixing with the underlying water. The stilling wall, however, causes a very satisfactory uniformity of tank displacement with no short-circuiting, surface currents or under-currents.

The Filter—This is an ordinary wood tub-filter with the rakes removed and a bisecting gutter placed across the center to reduce the longitudinal distance between edges of wash troughs. Virginia Beach (local) sand was employed. The effective size is about 0.4 m.m. and the uniformity coefficient 1.5. The rate is set by hand

RESULTS OF WATER TREATMENT AT VIRGINIA BEACH

(Parts per 1,000,000)

(1) Aeration—No Lime Added—Chloride of Lime, Settled and Filtered.

	CO_2	Iron	Carbonate	Total Alkalinity	Odor
Raw	125	2.2			Putrid
Aerated	20	1.4			None
Settled	19	1.1*			None
Filtered	15	0.05			None
Service Tap	...	0.15			None

(2) Aeration—Lime and Chloride of Lime—Settled and Filtered.

Raw	100	2.1	0	80	Putrid
Aerated	10	1.7	0	80	None
Mixed	0		6	94	None
Settled	0	0.40*	3	92	None
Filtered	0	trace	trace	90	None
Service Tap	2	trace	0	..	None

*Iron in settled water present as hydrate.

(3) Per Cent Removal: Chloride of Lime but no Hydrate of Lime.

By aeration	84	...
By settling tank	0	50
By filter	4	48
Total	88	98

(4) Per Cent Removal: Treating 12,000 Gal. per Hr. with 0.3 lb. Chloride of Lime and 1 lb. Hydrated Lime.

(Available chlorine dose = 0.9 p.p.m. Lime = 0.85 grains per gal.)

By aerator	90	..
By lime	100	..
By settling tank	...	81
By filter	...	18
Total	100	99

control and since the raw water pump cannot supply water in excess of the sanitary rating the operator holds the size of the effluent stream to correspond as nearly as possible to the raw water pumpage. This, with a little experience, offers no particular difficulty. The filter is washed from the elevated service tank at the plant. Control of wash water is regulated by observing a pressure gage on the wash line. The rate of wash is a rise of 18 in. per minute with 9 lb. pressure on the manifold. With the sand level 20 in. below the top of the gutters, this rate is very satisfactory. An additional sewer outlet had to be put in the filter to take off this volume of wash water, however.

Clear Water Tank—This consists of an old filter tub buried in the ground for three-fourths of its depth and covered with tight cover and composition roofing.

Plant Efficiency—The average results obtained through the plant under different conditions are shown by the accompanying table. It is apparent that the iron is just as effectively removed by the plant as a whole where lime is omitted as where it is used. In such case, however, a greater load is placed on the filter and a higher percentage of wash water is required.

The OH ions combining with the ferrous or ferric carbonate tends to form a larger and more feathery floc, which is ready for prompt settling upon emergence from the mixing chamber box. Such a floc, possessing a greater absorption quality and a tendency to more pronounced settling, removes a greater portion of dissolved organic and finely divided matters in suspension during retention in the settling tanks than is the case where lime is omitted. The portion of floc which flows onto the filter forms a highly satisfactory "blanket" which is more gelatinous and has less tendency to be sucked into the sand surface than when lime is omitted.

The greatest value from lime addition, however, is found in the carbon dioxide removal. When lime is omitted the filter builds up loss of head rapidly and finally becomes air-bound. With an increase of a CO_2 atmosphere under pressure in the filter, however, the CO_2 content gradually increases in the filter effluent. This is very undesirable in that under such conditions the water is increased in "aggressiveness" with attendant corrosion of mains and an objectionable iron content returned to the water before it reaches the consumer. As a general rule therefore it was decided to add lime at all times to the aerated water and maintain thereby in the settled water a CO_2 content of less than 2 p.p.m.

Bacteria Removal—Bacteria removal was not the end sought. The wells are so located as to be practically free of any danger of pollution. Due to the fact that these wells were being drawn on at a heavy rate, and also realizing the attendant pollution around construction jobs, it was thought advisable to add the chloride of lime. It later developed that this was warranted as some seepage was discovered entering the wood tub clear well before the swelling of the staves had made it entirely tight. Although the raw water has never shown B. Coli present, samples from the aerator and other points through the plant showed B. Coli present when, during the tuning up of the plant, the chlorine dose was allowed to become somewhat lower than desired and again when through accident some of the sludge in the settling tank was disturbed and became mixed with the supernatant water. All samples examined since July 26, 1921, show absence of B. Coli in raw and treated water, with the total count at the service tap varying between 5 and 50 per c.c. on agar at 37½ deg. As the chlorine aids in iron and odor removal the treatment is kept up.

Effect of Improved Supply on the Consumers—Since August, 1921, the improved supply has been universally used, replacing the necessity of using cisterns as laundry water supplies and bottled spring waters for the table. No complaint has been heard of further objectionable colors or odors at the hot water services.

The investigation, preliminary designs for plant and chemical tests were made by Messrs. Wagner and Enslow and the installation by William H. Taylor, Jr., director of public works, Norfolk, and his assistant, David A. Decker.

U. S. Topographical Survey Not Yet Half Done

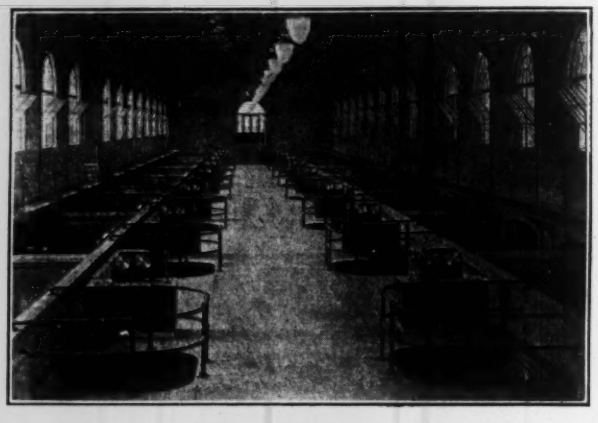
In summarizing the work of the Interior Department between Mar. 4, 1921 and Mar. 4, 1922, Secretary Fall reports that during that period the Geological Survey covered 14,000 sq. mi. with surveys for the topographic map of the United States. This work has been in progress for forty years and if it is to be completed within the present generation, Secretary Fall declares that the survey must have sufficient funds to cover several times this area annually. At present it is less than half done.

Operation and Tuning up of the Cleveland Filters

Comparative Uniformity of Results Obtained for Four Years—New Effluent Pipes—Baffling Reduced 75 Per Cent—Chemical Apparatus Revamped

By J. W. Ellms
Engineer of Water Purification, Water Department, Cleveland, Ohio

During the strenuous tuning-up period of the Cleveland water-filtration plant a remarkably even average set of results was obtained. The major changes made, aside from the reconstruction of the filtered-water basin in 1917, consisted in materially reducing the number of baffles in the mixers, discarding certain of the lime-handling machinery, installing a dust filter for reducing the lime-dust nuisance when unloading cars and substituting water ejectors for motor-driven pumps for feeding the various chemical solutions. On account of foundation difficulties, which caused serious settlements in various parts of the plant, portions of the plant could not be operated. It was for this reason that new effluent pipes were built to replace the original galleries and conduits provided. Practically speaking,



INTERIOR OF ONE WING OF FILTER HOUSE
Filter operating stands are shown on either hand.

operation did not begin until April 1, 1918, awaiting the reconstruction of the filtered water basin. A few filters were operated as early as Nov. 1, 1917. A brief description of the plant is here given, followed by operating results for four years and by brief mention of the early difficulties and changes. The original layout was described in *Engineering News*, Oct. 19, 1916, p. 732.

The plant, located on Division Ave. adjoining the pumping station at the intersection of this avenue and W. 45th St., was constructed in 1914-16. It is of the rapid-filter type and was built with the idea of softening the water, as well as purifying it from a sanitary standpoint. On account of unforeseen difficulties, it has not yet been possible to carry out the softening process. The filtration processes have, however, been conducted practically as was originally intended. The nominal capacity of the plant is 150 m.g.d., but as it is not possible to operate it in its entirety at present, its approximate actual capacity is 130,000,000 gal. daily.

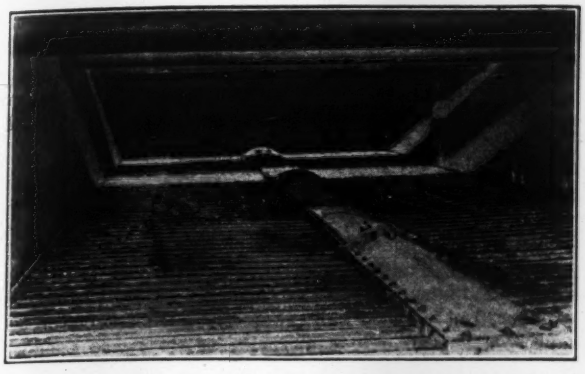
General Design and Operation Procedure—The raw lake water, lifted by the low-service steam turbine-driven centrifugal pumps in the pumping station just west of the filtration plant, flows through a riveted-steel pipe line 72 in. in diameter directly to the mixing chambers. This pipe line passes through the chemical house. In the pipe line is a Venturi meter which measures the rate of discharge, and which furnishes the necessary data for estimating the amount of chemicals to be applied. The prepared chemical solutions are pumped or ejected into the raw water in this 72-in. pipe line as it passes through the chemical-house building.

The chemical house contains large concrete storage bins, crushing and elevating machinery, weighing machines for measuring out the chemicals, slaking tanks and storage solution tanks for the lime solution, and storage tanks for the sulphate of iron, together with the necessary pumps, ejectors, heaters and ventilating fans for properly preparing the chemical solutions and for injecting them into the water.

Mixing Chambers—In the mixing chambers, where the water at the rated capacity of the plant as designed remains for 0.6 hr. and moves forward at the rate of 60 ft. per minute, the thorough mixing of the raw water with the chemicals applied is effected. These chambers are of the over-and-under baffle type and are built in four sections, each having six channels. Each section has been made entirely independent of adjoining sections by replacing the original wooden stop-planks with concrete cut-off walls. Owing to the excessive loss of head which would have resulted in attempting to use the channels fully baffled, it was necessary to remove 108 of the 144 over-and-under wooden baffles originally installed. Plugs were also provided for the underdrain openings, and relief pressure gates in the channel walls were fastened in place. The present travel at full capacity is 20 ft. per minute, against 60 ft. as originally planned. The loss of head at present is less than 3 ft. when operation is at the rated capacity. It was impossible to operate the mixing chambers with all the baffles in place as originally designed, and, in consequence, it is not known what the original loss of head would have been.

Settling Basins—From the covered mixing chambers the water passes out through an effluent conduit to the six settling basins located between the mixing chambers and the filter-tank building. Each basin is 227 ft. long, 141 ft. wide and 20 ft. deep. Two around-the-end baffles divide each basin into three parts. The water leaves each basin over a skimming weir through a channel connected by pipe lines with the main effluent conduit. This conduit extends along the north ends of the six basins, and is connected by four pipe lines with the main influent pipe line in the pipe gallery between the filter tanks in the filter building. Only five of the six basins are used; the remaining basin will probably require reconstruction before it can be used with safety.

Filter Tanks and Accessories—Each of the 36 filter tanks is supplied through a separate pipe line. The filter tanks, which are rectangular in shape, have a capacity of 4⅛ m.g.d. when operated at the usual rate of 125 m.g.d. per acre. All filter valves are operated by hydraulic pressure. A Venturi type of rate controller is used. A master rate controller has been provided so



PERFORATED-PIPE MANIFOLD IN 4 M.G.D. UNIT
Collecting and reverse flow wash pipes lead to central conduit.

that the filters may be operated at a variable rate if desired. The usual loss-of-head and rate-of-flow gages are provided. The perforated-pipe underdrain system is covered by about 22 in. of gravel and 27 in. of sand. The tanks are covered for about three-fourths of their length, but the operator is able to see the entire length of the water surface from the operating table by means of lights placed in the roof of the tank. The lateral gutters are U-shaped and are made of steel plate, but the central collecting gutter is of reinforced concrete. The filters are washed by the "high-velocity" method.

Clear Water Basins and Conduits—The filtered water is conveyed away from the plant by two effluent pipe lines, each serving 18 filters. These pipe lines connect with the filtered-water basin through a twin concrete conduit. The filtered water basin holds approximately 20 m.g.d. and is located on the west side of the plant beyond the Division Ave. pumping station. From this reservoir the water flows by gravity through two 60-in. cast-iron pipe lines to the suction header of the high-service distribution pumps in the pumping station. The filtered water is disinfected with chlorine at its entrance to the filtered water basin in a gate chamber on the north side of the basin.

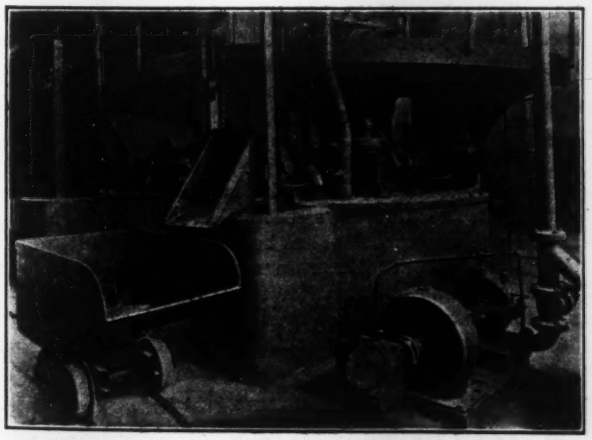
Operation and Analytical Data—The most striking feature of the results of operation and analytical data is their general uniformity, which is due largely to the rather even quality of Lake Erie water for the larger portion of the year. However, averages are somewhat misleading when they cover such long periods of time. The Lake water is, in reality, subject at times to sudden pollution, arising chiefly from high winds and storms that carry the polluted water from the mouth of the Cuyahoga River and the outfalls of the large sewers to the intakes. Fortunately, these periods of pollution are usually comparatively short, the water returning rather quickly to its usual uniform quality. The filter plant serves as an effective barrier to this sudden influx of polluted water.

Diatoms and Algae—For the larger part of the year the water of the lake is infested with diatoms and algae. These organisms have a marked effect upon operating conditions, principally in shortening the periods of service of the filters during the spring and summer months. Diatoms are apparently more effective in clogging the filter beds than the algae proper. No real remedy has been found to meet this trouble, since "breaking" of the filters with the coarse sand (effective size 0.45 to 0.50 m.m.) now in the filter beds has not proved satisfactory.

TABLE I. PRINCIPAL OPERATION DATA FOR 1918-21

Quantities of Water in Million Gallons	1918*	1919	1920	1921
Treated	22,880	31,576	30,170	30,955
Filtered	21,988	31,495	29,711	30,324
Pumped	21,974	31,495	29,712	30,324
Used for washing filters	615	447	416	550
Filter Operation				
Total No. of filtering hours	118,126	170,254	159,953	169,146
Ave. period of service hours	19.19	28.02	25.84	25.33
Total number of washings	6,574	6,063	6,163	8,128
Ave. time to wash filters (Minutes)	3.60	3.05	3.06	3.00
Per cent of wash water used	2.79	1.44	1.40	1.79
Quantities of Chemicals Used				
Lime, av. gr. per gal.	0.61	0.62	0.54	0.59
Lime, av. p.p.m.	10.	11.	9	10.
Sulphate of iron (av. gr. per gal.)	0.80	0.76	0.84	0.81
Sulphate of iron (Av. p.p.m.)	14.	13.	14.	14.
Sulphate of alumina (Av. gr. per gal.)	.....	0.75	0.95	0.86
Sulphate of alumina, (Av. p.p.m.)	.....	13.	16.	15.
Chlorine (lb. per mill)	1.2	1.04	0.98	1.52

* The 1918 results are for 9 months, April 1 to Dec. 31.



LIME SLAKERS AND LOWER PART OF LIME-WEIGHING MACHINE
The lime pump in the right foreground has been replaced by rejectors.

Changes in the Plant—The reconstruction of the filtered-water basin was completed in the latter part of the year 1917, and the two large filtered-water effluent pipe lines underneath the filter building were finished April 1, 1918. These pipe lines were required, as previously noted, to convey the water from the filters to the twin conduits leading to the filtered-water basin, since the effluent galleries, into which each filter was designed to discharge, had to be abandoned on account of foundation difficulties. The most westerly settling basin has never been used, nor has a portion of the effluent conduit of the settling basins which is located opposite this basin.

The hydraulic valves in the filter building gave more or less trouble from sticking or from moving too slowly. It was found that a pressure of at least 90 lb. per sq.in. at the valve was necessary. This pressure could not be maintained in the low-pressure system from which pressure was supplied, and in consequence the supply pipe was connected with the high-pressure system through a reducing pressure valve.

Rate controllers on the filters have been found to "hunt" to a marked degree. Just how serious this effect is upon the bacterial efficiency of the filters, it is impossible to say. Thus far the cause for the "hunting"

has not been definitely ascertained. The oversensitiveness of the pilot valve controlling the butterfly valve of the controller, or certain hydraulic conditions in the effluent pipe lines, may be the cause for the trouble. By placing a needle valve on the pressure pipe line leading to the pilot valve, the movement of the latter was retarded and in consequence, the rapid "hunting" of the controller valve was diminished.

Sand-Grain Incrustation—The use of lime in conjunction with sulphate of iron merely for coagulation purposes has been found to produce a rapid incrustation on the sand grains in the sand beds of the filters. During the year 1919 the average effective size of the sand increased 43 per cent from this cause or from 0.45 m.m. to 0.65 m.m. A sample of the top 6 in. of sand lost, when treated with hydrochloric acid, 41.2 per cent of its weight and 56 per cent of its volume. During 1920 the sand beds increased 9 in. in depth due to the accumulated incrustation of lime. The use of alum for a sufficient period will remove the incrustation and has been resorted to in attempting to remedy this trouble.

TABLE II. CHEMICAL AND BACTERIAL RESULTS DURING FIRST FOUR YEARS' OPERATION

	1918		1919		1920		191	
Turbidity, p.p.m.	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.
Lake water	20	180	24	180	20	160	18	135
Mixing chambers, effluent	25	145	24	140	27	140	20	174
Settling basin, effluent	6	22	6	24	6	35	3	12
Filtered water	0	0	0	0	0	0	0	0
Turbidity, Removed, Percentage								
By coagulation (increase)	25	.....	0	.....	35	.....	11	.....
By sedimentation (decrease)	70	.....	75	.....	70	.....	83	.....
By filtration (decrease)	30	.....	25	.....	30	.....	17	.....
Alkalinity, p.p.m.								
Lake water	91	99	92	100	91	98	92	100
Treated water	96	108	95	106	94	103	91	104
Settled water	93	101	94	104	92	103	90	104
Filtered water	89	100	91	102	90	100	93	102
Permanent Hardness, p.p.m.								
Lake water	17	30	18	28	18	22	20	30
Filtered water	23	34	22	30	23	28	25	38
Total Hardness, p.p.m.								
Lake water	108	120	110	124	109	118	112	124
Filtered water	112	130	113	125	113	125	118	135
Chlorine, p.p.m.								
Lake water	13	22	12	14	13	16	11	14
Oxygen consumed, p.p.m.								
Lake water	1.8	3.9	1.7	3.9	1.9	3.4	1.7	3.4
Filtered water	1.2	2.1	1.1	2.7	1.3	2.6	1.0	1.8
Bacteria per c.c., 37 deg. C. on Agar Media								
Lake water	285	4,800	278	7,500	421	8,295	399	11,900
Settling basins, effluent	91	1,850	117	2,560	248	4,990	169	6,070
Filtered water	45	930	29	480	72	1,310	60	1,630
Disinfected water	21	360	7	265	13	640	5	275
Percentage removal	92.6	.....	97.5	.....	97.0	.....	98.7	.....
B. Coli Index per c.c.								
Lake water	0.840	10,000	1.666	10,000	1.597	10,000	3.079	10,000
Effluent settling basing	0.205	10,000	0.277	10,000	0.528	10,000	1.792	10,000
Filtered water	0.066	1,000	0.087	1,000	0.110	1,000	0.439	10,000
Disinfected water	0.017	1,000	0.009	1,000	0.021	1,000	0.019	1,000
Percentage removal	97.98	.....	99.46	.....	98.60	.....	99.38	.....

Loss of Head Conditions—Since the changes in the mixing chambers, noted previously, were made, the loss-of-head conditions obtained have been entirely satisfactory. Coagulation as a rule is well developed at the end of the second of the six channels, indicating that a shorter period of mixing would be sufficient under the present method of operation. However, it must be remembered that these chambers were designed to care for a heavily limed water, and that softening of the supply was to be the result. This latter method of treatment has not been possible for a number of reasons, chief of which would have been the increased cost for chemicals and maintenance of equipment, and the inadequacy of the plant as designed to care for handling larger amounts of lime suspensions and lime sludges.

Chemical Hause Changes—Changes in the chemical house have been found necessary in order to handle the chemicals required to coagulate the water. The lime, crushed by a swing-hammer crusher, is broken up rather fine. The bucket elevator used to lift the lime from the discharging chute of the crusher permitted a considerable portion of the lime to drop back through the elevator boot after elevating it to the top of the chemical house. This leakage not only choked the crusher, but would finally stop the bucket elevator. In addition, a tremendous quantity of dust was produced which made it difficult for men to work in the car being unloaded. By installing a suction fan system, including a dust filter, this nuisance has been largely reduced. The elevator and crusher troubles are due primarily to the type of apparatus, which is not adapted to handling finely-crushed lime.

There has been no trouble in elevating the sulphate of iron or sulphate of alumina to the bins but there has been the usual and inevitable difficulty of cementation of "sugar" sulphate of iron, when stored in deep bins. Attempts to break through hardened crusts of this sulphate of iron, which form in these deep bins, have proved difficult and dangerous to the workmen employed.

Lime Difficulties—The preparation of milk-of-lime suspensions was found to be particularly troublesome until important changes were made. The slaking tanks discharged the hot milk of lime into a dilution tank below the floor level. In this tank was a high-speed stirrer driven by a gear from a Pelton waterwheel. The discharge from the wheel was used to dilute the milk of lime. The wheel also operated a centrifugal pump, which lifted the milk of lime from the tank and discharged it into the raw-water pipe line. The stirrer in the dilution tank was found to be too small and to be operated at too high speed. Constant trouble with bearings was encountered from the start. The pump impeller blades were worn out in about a year's time.

The imperfect stirring action in the dilution tank caused a permanent deposit of a large amount of lime sludge which had to be removed by men going down into the tank and digging it out, since it was considered more than probable that it would soon clog all of the drains if it were washed out to the sewer. The sludge had to be deposited on the ground outside the building, making an unsightly appearance.

To avoid these difficulties, water ejectors were installed to suck the milk of lime directly from the slaking tank and to discharge it into the raw-water pipe line. The results have been decidedly satisfactory, since the sludge problem has been practically eliminated, the use of motors, stirrers and pumps avoided, and the actual consumption of water reduced by about one-half. Ejectors have also been installed in place of motors and pumps to carry the sulphate-of-iron solution, and the sulphate-of-aluminum solution, when the latter is used, to the raw-water pipe line.

Automatic Weighing Machines of the type used have given fair satisfaction, but the gate on the lime weighing scales was found to be of incorrect shape to hold back lime containing so much fine dust. Lumps in "sugar" sulphate of iron have also proved trouble-

some at times in the "iron" scales. The latter have been operated, as a rule, automatically through a clock; the lime scales, however, had to be operated by hand, as only one clock was ever installed, and also because of the difficulty in holding back the fine lime when filling the weighing hopper from the bin supplying the scales.

A Direct Motor Drive for the lime-bucket elevator and screw conveyors has been substituted for a belt drive through a jackshaft. This has been of great advantage, since the frequent slipping off of this belt stopped the elevator and conveyors and necessitated opening the boot at the foot of the elevator and shoveling out the lime before the machinery could again be started, an extremely disagreeable operation for the workmen.

The Apron Conveyors onto which it was expected to shovel the chemicals for delivery to the crushers were found to be impracticable, since, in the case of the lime, they soon became so clogged that they could not be operated. The lime spilling from the sides of the conveyor filled the pit, and as it swelled with water which could not be kept out of the pit, the machinery could not be moved. These apron conveyors were finally removed and the pits filled with earth.

Automatic Level Gages in various parts of the plant gave considerable trouble from time to time due to clogging of pipes and to freezing of water in the connecting tubes. In consequence they have been removed and gage boards substituted.

Many other changes and improvements have been made from time to time in order to bring the plant up to its maximum efficiency, and to maintain it in the best condition. Constant vigilance and care are required to do this, as every conscientious operator knows. No two plants are exactly alike or require the same degree or kind of "tuning up."

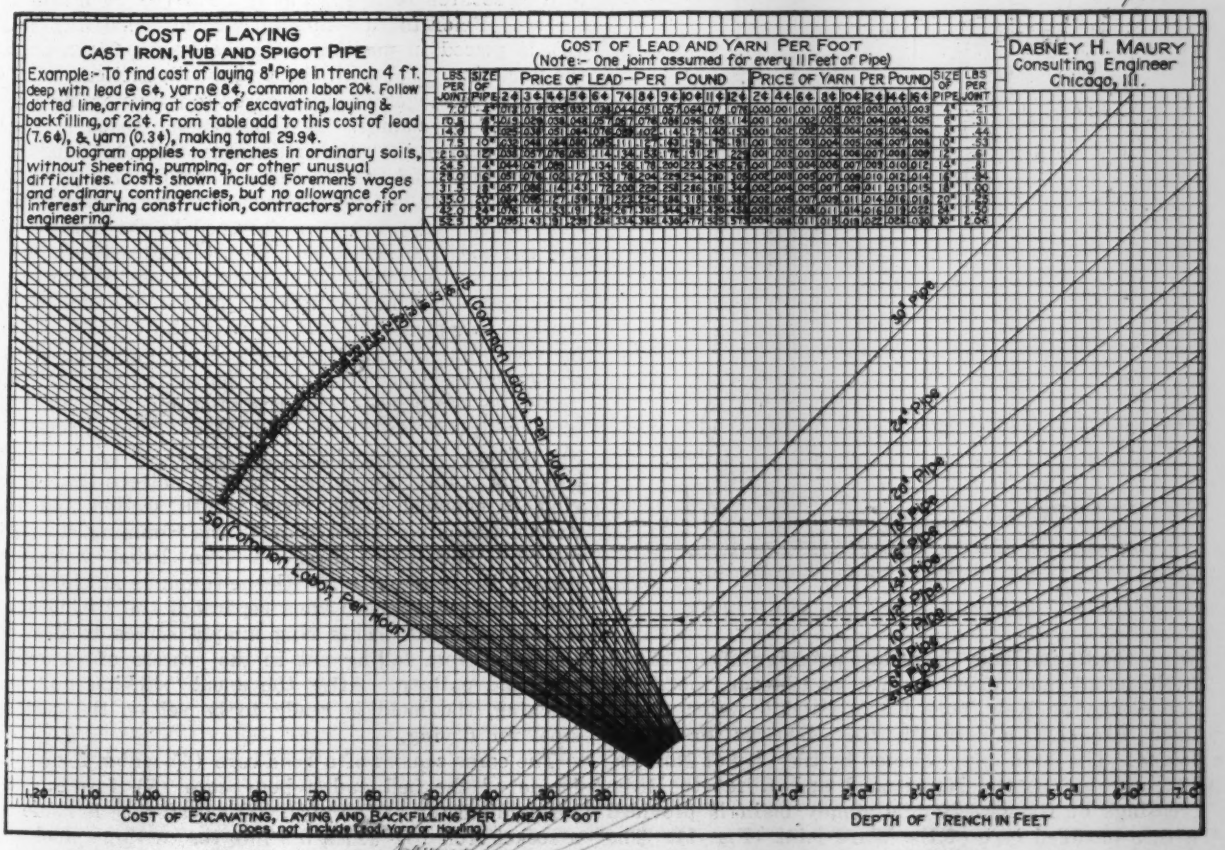
The writer wishes to acknowledge the cordial cooperation given him by Thomas S. Farrell, director of public utilities, J. T. Martin, commissioner of water, W. C. Lawrence, chemical engineer, and to the technical and operating staff in immediate charge in bringing this plant into operating condition.

Diagram Showing the Cost of Laying Cast-Iron Pipe

COMPILATIONS from actual costs of laying cast-iron pipe in 10 water-works plants have been combined in the accompanying diagram. The information was obtained in making appraisals for five water companies and five municipalities by Dabney H. Maury, consulting engineer, Chicago. F. G. Gordon, his principal assistant, prepared the diagram.

Since preparation the figures shown on the diagram have been compared with costs in a number of other cities and found on the average to check closely where conditions were not abnormal.

To use the diagram follow the direction arrows from trench depth to size of pipe, thence to common labor cost and cost per foot. Add to this figure the cost of lead and yarn per foot from the table which is made up with the quantity of lead assumed as 1¼ lb. to 1 in. of diameter of pipe.


COST OF LAYING
CAST IRON, HUB AND SPIGOT PIPE
Example:- To find cost of laying 8" Pipe in trench 4 ft. deep with lead @ 6¢, yarn @ 8¢, common labor 20¢. Follow dotted line, arriving at cost of excavating, laying & backfilling, of 22¢. From table add to this cost of lead (7.6¢), & yarn (0.3¢), making total 29.9¢.
Diagram applies to trenches in ordinary soils, without sheeting, pumping, or other unusual difficulties. Costs shown include Foremens wages and ordinary contingencies, but no allowance for interest during construction, contractors profit or engineering.
COST OF LEAD AND YARN PER FOOT
(Note:- One joint assumed for every 11 Feet of Pipe)
DABNEY H. MAURY
Consulting Engineer
Chicago, Ill.
COST OF EXCAVATING, LAYING AND BACKFILLING PER LINEAR FOOT
(Does not include Lead, Yarn or Housing)
DEPTH OF TRENCH IN FEET

COST OF CAST-IRON PIPE LAID IN THE GROUND

Making 30-Inch Flexible Joint Cast-Iron Pipe

Spherical-Shaped Bell and Spigot on Each Length Machined to Give Flexibility at Every Joint—Foundry Practice

By William G. Hammerstrom
Chief Engineer, Lynchburg (Va.) Foundry Co.

A GREAT variety of designs of flexible joints for water pipe are on record, each differing but little from the original Ward joint patented by John F. Ward in 1863. A number of such lines have been laid in various parts of the country, the longest perhaps

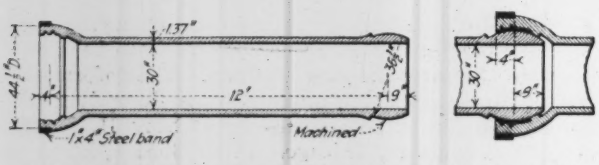


FIG. 1. PIPE WITH INTEGRAL CAST FLEXIBLE JOINT

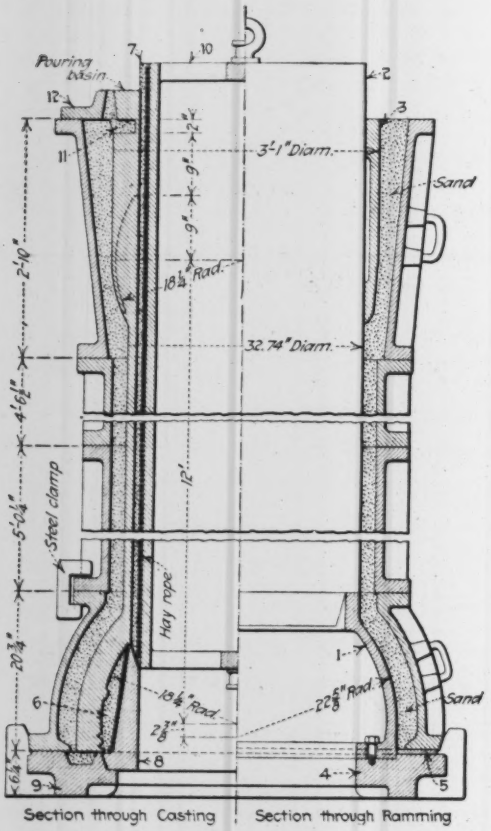


FIG. 2. PATTERN AND CORE EQUIPMENT

being the 24-in. Lake Champlain crossing about 15,000 ft. in length and, more recently and larger, the 36-in. line conveying New York City's Catskill water supply from Brooklyn underneath the Narrows to Staten Island. The 30-in. pipe selected by the City of Norfolk, Va., for use at the Nansemond and Elizabeth River crossings of its new 20-mile supply main is provided with a modified type of the Ward joint (Fig. 1). The spigot end is made to form a perfect bell with a radius of 18¼ in. and carefully machined to gage. A shoulder cast integrally provides a definite stop at maximum deflection of the pipe without injury to the lead at the face of the bell. The inside of the bell is provided with a ring which serves the purpose of holding the lead and of centering the pipe to insure a uniform lead space. This ring is also carefully machined to the same radius as the spigot. On the outside of the bell is shrunk a 1 x 4-in. steel band to protect the bell from breakage in handling and transportation. The pipe corresponds to Class D of the American Water Works Association standard. It was made by the Lnychburg Foundry Co., of Lynchburg, Va.

Fig. 2 illustrates by two half sections the manufacturing process. The iron flasks in which the pipe is molded and cast are made up of four carefully machined main sections—the bottom and top bell pieces and two straight body sections. Each one of these is made in two halves and held together by means of heavy steel clamps tightly secured by steel wedges. The body sections are hinged to facilitate the removal of the pipe from the flask. Since these flasks are subjected to much rough handling they are designed very heavily to prevent costly renewals due to breakage. To facilitate lifting the flasks out of the pit they are provided with heavy integrally-cast steel-hook eyelets reinforced by heavy bosses.

The pattern equipment for making a pipe consists of a head pattern (1, Fig. 2), forming the outside of the bell, the pipe body pattern (2) which makes the outside diameter of the pipe and the spigot pattern (3) forming the spigot end of the pipe. The head pattern is secured to the ramming steel (4) by means of screws. Prior to ramming up a mold the lifting ring (5) is placed in position over the head pattern on to the ramming stool with the bell mouth sections of the flask clamped together and secured to the ramming stool by means of clamps. A proper sand space is thus formed between the outside diameter of the head pattern and the inside of the bell mouth section and into this space the sand is tightly rammed. The straight sections of the flask are then fastened to the bell mouth and the body pattern fitted into the head pattern. The resulting space is filled with sand and rammed by means of long steel rod hand rammers. In a similar manner is the top bell piece rammed up with the spigot pattern in place, fitting snugly over the body pattern. After the ramming is completed the spigot pattern is first drawn vertically up out of the sand and the body pattern is drawn out in like manner. This removal of the pattern is accomplished by means of an overhead traveling crane. To remove the head pattern the lifting ring is clamped to the bell mouth section and the clamps fastening this section to the ramming stool removed. The entire flask is then lifted vertically, leaving the head pattern with the ramming stool. After these parts have been thus separated the lifting ring is also removed. This ring simply serves to prevent the sand from falling out in the process of removing the head pattern. After the usual "slicking up" and blacking, the mold is ready to be set on the casting stool for drying.

The cores consist of a head core (6) which forms the inside of the bell and a body core (7) forming the inside diameter of the pipe. The head core is made on a socket iron (8) which fits into the castings stool (9) and which also supports the body core (7).

The processes of making the head core is shown by Fig. 3 and its sub-title.

In making the straight body core the cast-iron core barrel (10, Fig. 2) is furnished at both ends with steel spindles which fit into bearings on the core strike to provide an easy turning of the barrel in the making of the core. An air motor installed at the upper end furnishes the power for revolving the barrel. An even layer of ½-in. hay rope is first wrapped around the barrel, after which the first coating is applied. This coating consists mainly of clay which after drying cracks and provides the vent which is necessary for the escape of gases in the casting of the pipe. The barrel

FIG. 3. MAKING THE HEAD CORE FOR BELL END

On the outside of the socket iron a layer of ½-in. hay rope is wrapped. The part is then placed inside of a core box and sad rammed in the usual manner. The lower section of this core box is made in two halves to enable its removal after forming the ring for the lead stop and the double lead grooves. The upper section of the core box is made to conform with the curvature of the inside of the bell where it joins the body core. After the core is completed it is placed in the casting stool ready for drying. The complete core is shown at the right, the head pattern with lifting and ramming stool at left.

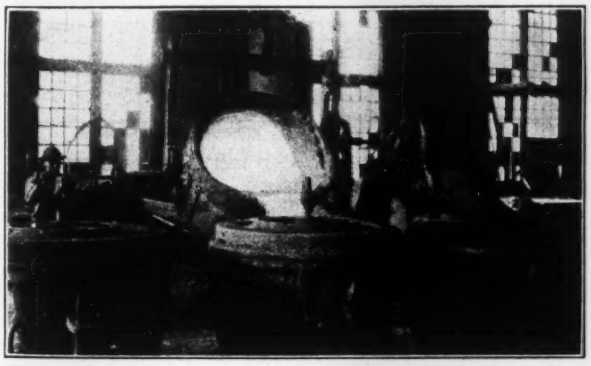


FIG. 4. POURING CENTRAL OF THREE PIPE FLASKS

The flask is not moved from the time it is placed for drying until it is ready to knock out.

containing the first coating is placed on an iron car with racks, each car holding three cores. The car is placed in the drying oven where after about an hour the cores are taken out and a second coat, consisting of sharp sand and loam, is applied. This is followed by a thin coating of anthracite blacking. After drying for three to four hours the core is ready for use. Care is, of course, taken that the core is absolutely straight and made to an exact outside diameter, allowance having been made for shrinkage, etc. To allow for a free vent the core barrel is perforated with a number of ⅝-in. diameter drilled holes. A third and smaller core is a centering core (11, Fig. 2) placed at the top of the mold. This core is circular and about 2 in. thick, with an inside diameter large enough to allow an easy fit over the body core. A tapper on the outside diameter permits a bearing for the core on the mold which is thus held in place. On the inside diameter are rectangular slots made or cut out to permit the entrance of the molten metal in pouring the pipe. On top of the bell mouth section is placed a cast-iron circular runner (12, Fig. 2) the inside of which is sand lined. This forms a basin into which the metal is poured and from which it feeds through the slots of the head core and into the pipe.

After the mold has been made the complete flask is clamped to the casting stool carrying the head core

FIG. 5. READY TO TAKE PIPE FROM FLASK

Casting-stool with socket iron is unclamped and removed and flask placed horizontally on knock-out skids. Flask clamps are then knocked off, one half of flask raised, whereupon pipe rolls out and sand flows to pit below for testing and reuse.

(Fig. 2) and the entire unit placed in a 12-ft. deep pit on top of fire boxes for drying. The drying of the mold and head core is done simultaneously, usually over night. The body and the centering cores are made of dry sand and are dried separately in ovens. Prior to the pouring the body core is lowered into the mold,

the lower end of the core fitting into the tapered top section of socket iron and is thus supported in a vertical position. The centering core is then placed into position and after the runner has been secured and the basin formed the pipe is ready for pouring.

Fig. 4 shows the pouring of one pipe. Since the finished pipe weighs about 7,400 lb. it is necessary to use a ladle of five tons capacity to allow for shrinkhead, runners, gates, etc. About an hour after the flask has been poured the core barrel is drawn out and the pipe permitted to remain in the flask from five to six hours to cool off, when the flask is hoisted out of the pit and steps are taken to remove the pipe. Fig. 5 shows the flask immediately after removal from the pit.

The next steps are to place the pipe on skids for cleaning and chipping. The dry sand cores are cut out by means of long steel rods, sharpened at the end. The riser, or extra length of pipe beyond the spigot end into which foreign matters rise to ensure a sound spigot, is cut off in a lathe. The pipe is then coated and tested under hydraulic pressure and otherwise, as called for by the specifications of American Water Works Association. Finally, the pipe is transferred to the machine shop for the accurate finishing of its bell and spigot ends in special lathes, and for shrinking on the steel band. When the machinery has been completed the pipe is once more transferred and the steel band shrunk, making the pipe ready for shipment.

Maintenance Cost of Drainage Works

Drainage works for the removal of seepage and excess water are provided on a number of the irrigation projects of the U. S. Reclamation Service, and a tabulation of the cost of maintenance of both open ditches and tile drains is given in the January number of the *Reclamation Record* by C. E. Lounsberry, assistant to the drainage engineer, U. S. Reclamation Service. A summary of his table is given above. It appears evident that these irrigation drainage works receive much greater attention than those of ordinary land drainage, the neglect of the latter being notorious and occasionally involving heavy reconstruction costs. Patrolling, in particular, is practiced generally on the government projects but rarely on private projects, although a patrol system for the latter was noted in *Engineering News-Record* of Jan. 26, 1922, p. 141. Mr. Lounsberry points out that the cost herewith are for periods averaging 4.37 years on ditches and 3.56 years on tile drains.

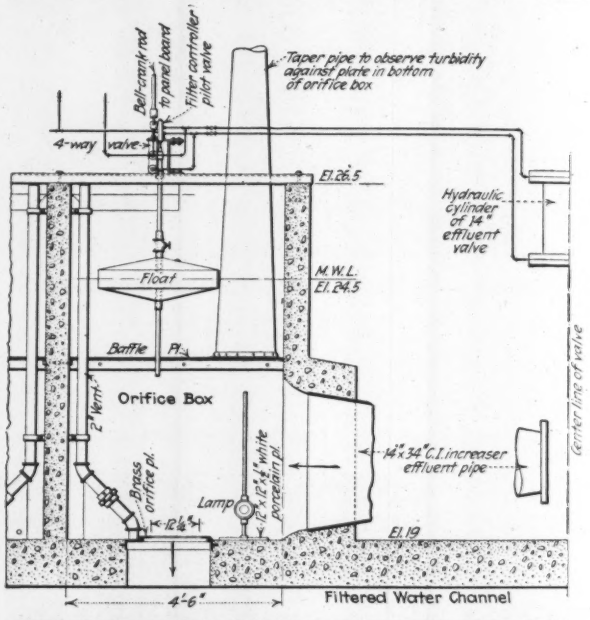
MAINTENANCE COSTS OF DRAINAGE DITCHES

	—Minimum—		—Maximum—		—Average—	
	Cost Per Mile-Year $	Per Cent	Cost Per Mile-Year $	Per Cent	Cost Per Mile-Year $	Per Cent
Drainage Ditches						
Patrolling	0.90	3.26	13.03	6.6	6.10	8.5
Clearing weeds and debris	8.35	20.20	17.71	9.0	17.96	25.0
Clearing silt and slips	1.58	5.50	22.55	11.5	16.32	22.7
Repairs to structures	12.36	43.30	89.05	45.4	11.63	16.2
Minor expenses, plant and equipment	1.18	4.1	14.53	7.4	3.90	5.4
Miscellaneous	0.26	0.9	....	....	0.96	1.3
Unit field cost per mile-year	24.65		156.89		56.87	
Overhead	3.91	13.70	39.38	20.0	14.76	20.6
Total unit cost per mile-year	28.56	....	196.27	....	71.63	....
Tile Drains						
Patrolling	....	....	....	....	.53	0.9
Clearing tile and trap boxes	5.96	68.8	24.24	24.3	14.72	25.0
Repairs to tile and trap boxes	.36	4.2	37.56	37.6	31.00	52.6
Minor expenses, and plant and equipment charges	....	....	1.24	1.3	2.54	4.3
Replacement of drains	....	....	....	....	2.15	3.6
Hydrometry	....	....	....	....	0.01	....
Unit field cost per mile-year	6.32	....	63.05	....	50.93	....
Overhead	2.33	27.0	36.76	36.8	7.98	13.5
Total unit cost per mile-year	8.65	....	99.82	....	58.93	....

Operation Control Panels for the Sacramento Filters

Upright Panels—Air Rate-of-Filtration and Loss-of-Head Gages—Colored Water Valve—Opening Indicators

UNIQUE filter control panels and novel methods of handling the filter operation are included in the design of the filtration plant now under construction at Sacramento, Cal. The panels are upright, the valve-opening indicators are colored liquids in glass tubes, the loss-of-head gages and rate-of-filtration gages are air gages, and the wash-water rate is indicated directly from a Pitot tube in the wash-water line. As designed, the Sacramento filters will all automatically respond at the same rate to the draft upon the filtered-water basin.

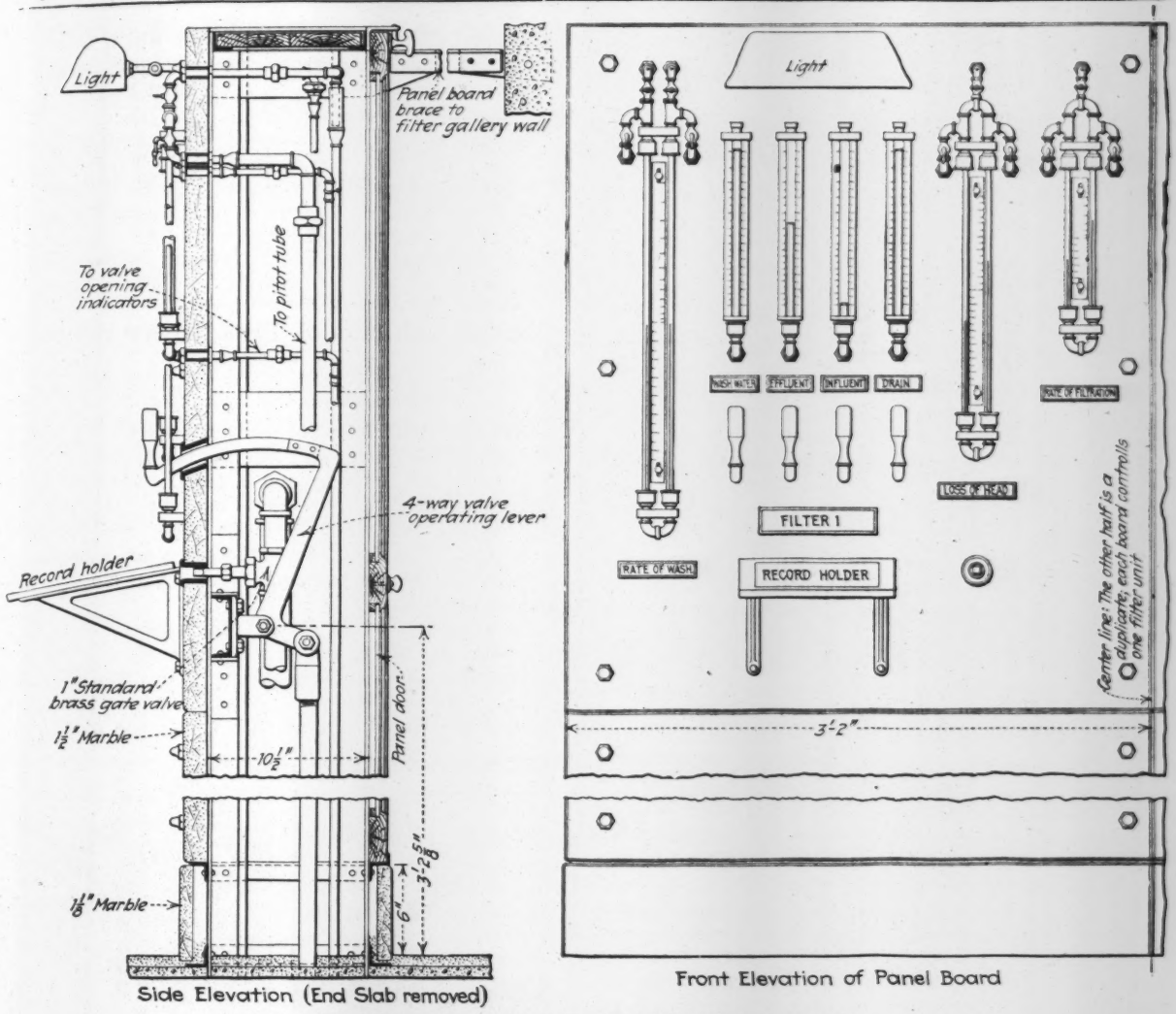


EFFLUENT ORIFICE BOX AND EFFLUENT VIEW-PIPE

The condition of the water yielded by each filter may be seen through a view-pipe, which tapers outward from the floor downward to give a 20-in. field of vision over a 12-in. white porcelain plate at the bottom of the orifice box.

They will accordingly respond to the pumps and the demand made upon them by the consumption or draft upon the distributing pipe system.

The controllers are of the Harrisburg type but will be improved over the early design. The discharge will be through fixed, horizontal, circular orifices, 12¼ in. in diameter. The normal depth of water over the orifices will be 5.5 ft., but this depth can be increased to 6.5 ft. if desired. This means that the filters will not come into full operation until the filtered-water basin is drawn down to that depth below the high-water mark at which the water-level control float is set. At the high-water mark the filters will automatically stop filtering. Such a condition can never exist inasmuch as the minimum rate of draft is fully 10 m.g.d. The eight filters are designed to yield 4 m.g.d. each, at the 125-m.g.d. per acre rate. Their maximum rate of yield is at present fixed at 6 m.g.d. each, or 48 m.g.d. with eight units in operation at a rate of 187.5 m.g.d. per acre. When the filtered water basin is drawn down to give the full static head on the orifice plates in the bottom



FILTER-CONTROL PANEL BOARD FOR SACRAMENTO

Valve-opening indicators are colored liquids in glass tubes; wash water rate is indicated directly from a Pitot tube. loss-of-head and rate-of-filtration gages are air gages;

of the orifice boxes, this maximum rate will be reached by the filters, but it cannot be exceeded except by using larger orifices or by increasing the head on them to a limited extent. The filters have been designed for a maximum loss of head of 10 ft., which can be increased somewhat. Ten feet represents the difference in elevation between the water surface on the filters, as designed, and that in the orifice boxes.

The floats in the eight orifice boxes will all be set at the same level and all filters will operate at the same rate within expected small limits. Therefore there will be but one rate-of-filtration recorder and indicating dial for the entire plant. The recorder will be of the integrating type to give a straight-line diagram of rate; that is, all ordinates on the recorder will represent the same amount of water. There is thus no necessity of providing in each operating panel an expensive rate-of-filtration recorder.

The hydraulic valves controlling the operation of the filters are governed by 4-way piston pilot valves of the leakless, enclosed type. The spattering of water which occurs at the Harrisburg plant will thus be avoided. The 14-in. effluent control valve is a stop or shut-off valve, as at Harrisburg. Operation of the 4-way effluent valves from the panels will automatically cut out the operation of the pilot valves actuated by the floats, as is the case also at Harrisburg. The design is estimated to save $1,500 per filter unit on the controlling apparatus alone.

The usual 4-way rotary cocks will not be used but 4-way, leather-cup, piston-type valves, designed and manufactured for 500-lb. per square inch pressure, will be installed. This type of valve is exceedingly rugged and will not leak. The valves will be set down in the pipe gallery on the back wall of each filter orifice box and directly beneath the corresponding operating panel, from which they will be operated by lever handles and standard bell-crank connections.

In usual operation these handles will all be pushed back against the panel. Therefore, if any handle is out, one can tell at a glance that either the filter is being washed, or else some valve has been tampered with. A master control-valve will prevent any harm being done by such tampering. It is opened when washing is begun and closed when the filter is returned to normal operation. The control valve shuts off the supply to all

but the float-operated 4-way valves, and will be turned by a special key which the operators only will have.

All strings or wires connecting valve stems to pointers have been done away with on valve-opening indicators on the panel board. Instead, colored liquid piped from miniature pumps actuated by the valve stems to glass tubes on the panel boards is to be used and the corresponding scales will show both the height of valve opening and the percentage of total waterway through which the water is passing. An outside-packed plunger rod, attached to the valve-stem extension above the hydraulic cylinder, will displace its own volume of liquid as the valve closes or opens. The movement of the plunger will make the colored liquid in the glass tubes rise or fall, corresponding to the motion of the valve. The scheme works equally well with the valve turned up, down or sideways at any angle.

The rate of washing will be instantaneously indicated by a differential gage on each filter-control panel, connected to a Pitot tube of special design in the wash-water line to each filter.

The loss of head on each filter will be shown by a differential gage with terminals connected to the water surface above the sand and the effluent pipe on the filter side of the control valve. This gage will be an air gage on the principle, but not the design, of the "Pneumercator."

A rate-of-filtration indicating gage will be provided on each panel. Like the loss-of-head gage, it will be of the differential, air type, with terminals connected to the upstream and downstream sides of the filter-orifice plate. Thus in reality the head on the orifice will be indicated, but the scale on the gage will be calibrated to show the corresponding discharge through the orifice in millions of gallons per day.

At the end of each operating panel is a filtered-water view-pipe through which one can look down through the 5.5-ft. depth of water in each orifice box. Above the filter-gallery floor the view-pipe is 4 in. in diameter, but from this floor downward it is tapered to give such an angle of vision as will permit the observer to look at the water over the area of a 20-in. diameter circle. At the bottom of the orifice box below each pipe a white porcelain plate will be placed. Just above this plate will be an electric bulb in a marine-glass fixture which is adjustable or removable through an opening in the side of the tapered view-pipe. A push-button type of electric switch will be placed at the side of each view-pipe and must be held down while one is making an observation of the character of the filtered water. This arrangement will prolong the life of the electric lights.

Each panel will be illuminated at night by a panel light. Each panel also carries its own shelf for 8½ x 11-in. record sheets for operation data, the loose-leaf system being employed. The provision of such a shelf is intended to imply that the records of each filter are an immediate, inseparable and integral part of its operation.

Within easy reach of the panel boards will be switches to lights which will illuminate the filter surfaces for night working, and also submerged lights to determine the turbidity of the wash water so that the end point in washing can be studied or watched at night.

The panels will have angle-iron steel frames supporting selected marble fronts and ends. The interior of each panel board is made entirely accessible through the removal of two light, paneled doors which form the back of the panels. All apparatus and piping requiring oiling or adjustment are at a convenient height above the filter-gallery operating floor.

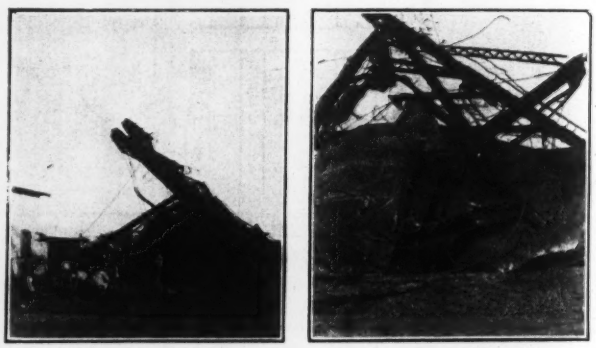
The designs for the Sacramento filters are being carried out under the general direction of Prof. Charles Gilman Hyde, consulting engineer. C. G. Gillespie is resident engineer, K. B. Foster is assistant hydraulic and filtration engineer and Harry N. Jenks special assistant engineer on design. Frank C. Miller is city engineer.

Rusted Columns of Tank Tower Buckle

By W. F. Heath
Assistant Engineer, Cameron County Water Improvement District No. 2, San Benito, Tex.

A WATER tank failed in this city recently, by simple collapse under vertical load, as the result of weakening by severe rusting and neglect. There was no wind. The tank did not fall to one side, but just sat down, as the two views herewith show. Fortunately, no one was injured, although the structure was within 20 ft. of one of the principal streets and close to the pumping station.

This tank was of 40,000 gal. capacity and was supported on an 80-ft. tower, of standard four-column construction. It was built about 1910. With proper care it should have lasted forty years. About two years ago it was painted, but at that time none of the old



COLLAPSE OF TANK TOWER DUE TO RUSTING

paint or rust was removed before putting on the new paint. The lattice bars of the columns had rusted in two in many places, and rust had also attacked the main channel members of the columns.

Six months ago the San Benito Water Co., which owned the tank, was advised by W. E. Anderson, chief engineer for the Cameron County Water Improvement District No. 2, that the tank should be taken down as soon as possible. At that time all the lattice bars of the upper panel of one column had rusted out. A few months later this column section bent to a noticeable curve outward, and he advised taking the tank down immediately. Nothing was done, however, except to drain the water from the tank.

It is said that on the morning of the failure the plant engineer sent a man to open a valve leading to a main. Instead, he opened the valve leading to the tank, and the tank filled to the point where it collapsed.

The intensity of rust action in this coast countr is hard to believe by anyone who has not lived here. I have seen "flivvers" not more than a year old with holes rusted in the fenders.

Motor Trucks Collect and Deliver Garbage to Farmers for Pay

By W. F. Bates
Town Engineer, Montclair, N. J.

MOTOR trucks heavily manned are being used by the town of Montclair, N. J., to collect garbage and to deliver it outside the town to farmers for rates of compensation fixed by obtaining bids. For collection during the seven months from Nov. 1 to June 1, when only two collections a week are made, three motor trucks are used. For the other five months of the year when the collections per week number three, an extra truck will be required.

There are now in use three 2½-ton Packard trucks with Van Dorn hoists and special 4-cu.yd. garbage bodies with flare tail gate. Each truck is manned with a chauffeur and either three or four collectors according to the season. The fourth collector is employed during extreme cold weather when the garbage is frozen and hard to remove from the receptacles or when there is snow on the ground. The trucks are loaded a little under levelful, giving about 3½ cu.yd. per load. The average haul of the loaded truck is 5 miles per load and an average of two loads a day is made.

Specifications—Bids were received under specifications calling for the number of loads each bidder would take and the price that he would pay per load. The invitation for bids stated that the contract would be awarded to the bidder offering the highest price per load and that where two or more bidders offered the same unit price the bids would be accepted that offered the nearest dumping grounds. The town reserves the right to limit the amount delivered within 5 miles of a point on the western boundary of the town to 60 per cent of all garbage collected in the town and to limit to 40 per cent likewise the garbage going out of town on the north boundary.

The specifications provided that the dumping grounds offered must be so located that they could be "reached over hard-surfaced roads and the route over the bidder's premises leading from the public road to the dumping place must be kept in a condition suitable for the use of the town's auto trucks."

The town reserves the right to cancel any agreement made with any bidder in case "any proper authority outside of Montclair stops the hauling of the garbage through its territory or requires the same to be hauled over roads other than those provided with a hard surface, and further that no claim for damages would be made by reason of such cancellation." Bidders were also required to hold the town and its agents "free from any claims for damages that may arise because of the condition in which the dumping ground is maintained, or because of any garbage there dumped."

Bids and Awards—Eight bids were received for quantities ranging from 1 to 24 loads a week, but only one bidder offered to take more than 6 loads a week. There were two bids at $1.25 a load, five at $1 a load, and one at $0.75. The bidder who proposed to take 24 loads a week offered to pay $1 a load.

At the time the bids were received only 35 loads a week were being collected. The highest bidders were given the number of loads they bid for and the remainder was apportioned among the other bidders, taking into account the length of haul. An attempt is made to furnish some garbage to each bidder so as to hold all the bidders as customers for the summer collection, estimated at 50 loads.

Previous Methods—In May, 1918, when the writer took charge of the Engineering Department of the town, and for a number of years previous to that time garbage was collected by horse drawn steel carts and dumped into a hopper on a farm situated about two miles from the center of the town and less than one-fourth of a mile from a residential section. The garbage was disposed of by the owner of the property, a portion by sale to farmers for hog feeding and the balance piled or spread on the land for fertilizer. The cost to the town for rent and maintenance of the dump was $770 per year. Records show that this dump had been a constant source of complaint for a number of years.

Soon after the writer took charge an investigation showed that farmers from surrounding towns, without permission, were coming into town and collecting ahead of our men. There existed such a demand for the garbage on account of the high cost of feed that it was decided to make use of these farmers and save expense to the department.

Farmer Collection Regulated—With the assistance of the police and the health officer all the farmers were notified that in order to continue the collection they would have to work under our direction. Arrangements were made by which the farmers were to furnish the teams, with drivers, and the town the collectors, the farmers to receive the garbage free of charge in exchange for the use of the teams. Enough farmers agreed to this arrangement so that for eighteen months all the garbage was removed from the town, at an average saving of $20 per day for teams. This method caused a few complaints, as sanitary carts being too heavy for the long hauls could not be used to advantage by the farmers, but the writer considered that the small amount of leakage from the carts caused much less nuisance than that from garbage stored at the dump.

Early in 1920 the decrease in prices made it unprofitable for the farmers to continue and a number gave up the collection, while with others we were obliged to pay the driver. This made it necessary to use the dump again, which on account of being leased land could not be satisfactorily controlled and complaints became numerous from the residents in that vicinity. The nuisance at the dump became so acute that some other method of disposal was imperative.

Incineration Proposed But Given Up—Thorough investigation of different methods of disposal was made and preliminary plans for disposal by incineration considered, but on account of the present state of incineration, with vast differences of opinion among experts, and the opposition which developed to the erection of an incinerator in every section where a site was available, the matter was indefinitely postponed and the present system adopted. This system is working very satisfactorily from the sanitary standpoint, and at less expense than for incineration, and should continue to serve our needs for a number of years, or until the surrounding country is more thickly settled and feeding places become a nuisance.

The work as now conducted is under the general direction of Dr. James T. Hanan, commissioner of streets and public improvements of Montclair, with the writer in direct charge.

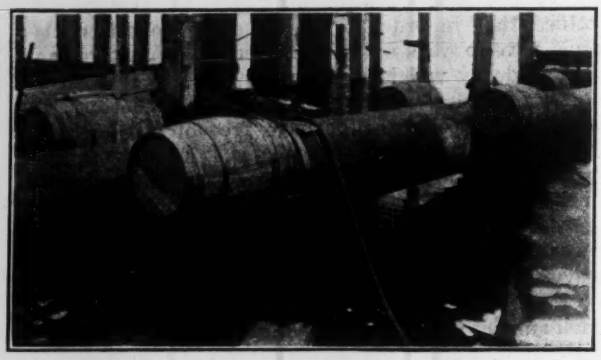
Submerged Intake For 24-in. Pipe Placed Without Diver

Concrete Anchor Block Cast on Shore, Floated to Place and Sunk Simultaneously With 250-Ft. Bell-and-Spigot Pipe

By George W. Pracy
Superintendent, Spring Valley Water Co.

THE SPRING VALLEY WATER CO., which serves the City of San Francisco, recently renewed the intake of Lake Merced pumping station after it had been in service twenty years. This station, which has a capacity of 7½ m.g.d., had been taking water from the lake through a 24-in. suction line supported on a wood pile trestle. The trestle had decayed, the joints in the suction line were giving trouble by admitting air and it was found that a new and shorter route to deep water could be used. The old pipe sections were used in laying the new line which was placed directly on the ground and on the lake bottom.

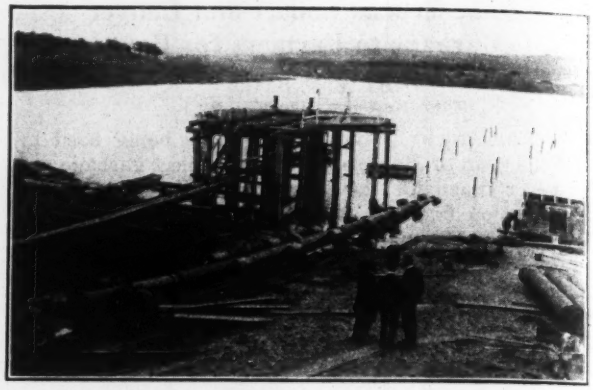
A combined concrete anchor block and screen support was cast on shore, floated to position, and, before being sunk, was attached to the portion of the pipe line to be



SECTIONS OF 24-IN. PIPE READY FOR LAUNCHING
Note clamps and bolts to prevent joints from opening. Pipe trigger for tripping wire sling is on far side of pipe. Manila rope attaching bolster to pipe was cut before launching.

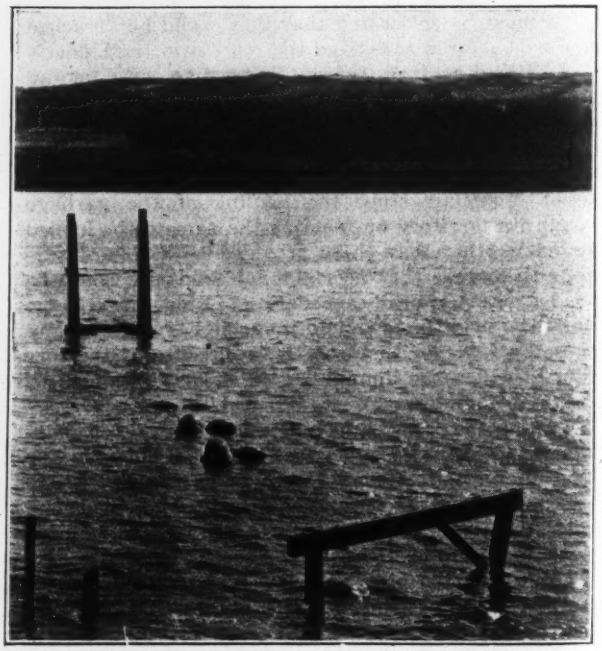
submerged which had been floated into position separately. When the connection of floating parts had been made, pipe line and anchorage were successfully sunk at the same time. Advantages of this plan of construction were that it was carried out by the company's regular gang and without the use of a diver, the cost was about one-quarter that of replacing the old line on a trestle, joint maintenance was eliminated on the submerged section and the shorter suction line reduced the friction head. With the new intake the lake can be drawn down 5 ft. lower than before.

The shore where the new intake is located has a gentle slope reaching the lake's maximum depth of 14 ft. at the present water stage, about 250 ft. from the shore. In the preparation for laying the new intake the surface of the ground between the pumping station and the water's edge was smoothed to an easy vertical curve and pieces of 2 x 6-in. timber 4 ft. long taken from the old wharf were laid on this slope like railroad ties. Longitudinal runs of 2 x 4-in. timbers were then spiked on to form the rails of a 24-in. gage track. In addition to the track built down to the water's edge, a 20-ft. section was put together on land, floated into place and sunk so that its outer end was in 3 ft. of water.

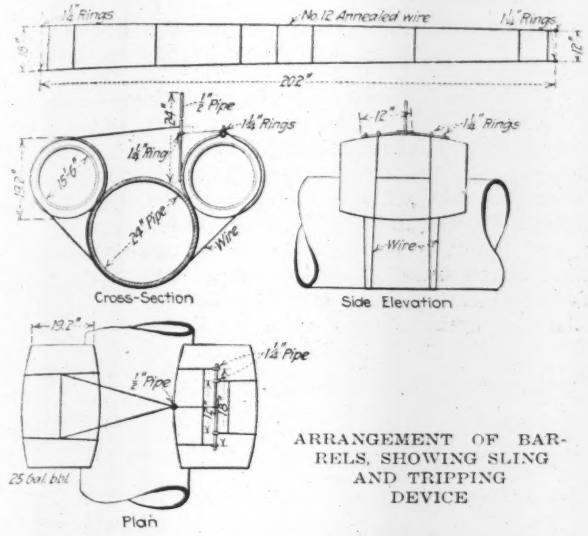


GENERAL VIEW OF INTAKE LINE, FIRST SECTION ENTERING WATER
Abandoned intake structure in center, concrete crib at right.

The old suction line consisted of 12-ft. sections of cast-iron pipe ⅜ in. thick, weighing 3,025 lb. per section. Twenty-two of these sections were taken up, cleaned, and sledded over to the site of the new work where they were mounted on a four-wheel, 24-in. gage truck on the wooden track. Each section rested on a wooden bolster cut to fit the pipe circumference and bolted to the truck. The second section of pipe, after being attached to the truck, was lowered down the track until its spigot entered the bell of the first section, the same as though the pipe were being laid in the ditch. Four pieces were put together this way and then the lead joints were run and calked. The pipe had only the ordinary standard bell. After the joints were calked iron bands were clamped around each section, just above the spigot and below the bell of each joint. The bands on either side of a joint were connected by a pair of bolts, one being placed opposite each end of the horizontal diameter of the pipe. These bolts, while preventing actual separation of the pipe



VIEW TAKEN JUST AS THE CRIB AND PIPE SUBMERGED
Note simultaneous appearance of pairs of barrels.



ARRANGEMENT OF BARRELS, SHOWING SLING AND TRIPPING DEVICE

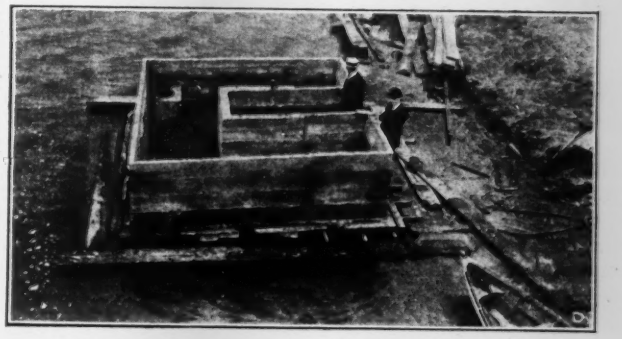
sections, would allow a certain amount of play or articulation in case any tensile strain should be put on the line in the process of floating and sinking it. As the assembly and jointing of each four-length section was completed, a rope was fastened around the upper bell and by means of block and tackle the line was let down the track to make room for the next four pieces. The front end of the first pipe was sealed with a 24-in. wooden plug calked in with oakum to make it watertight. Just before each length of the pipe went into the water two 25-gal. barrels were fastened to it by means of a wire bridle arranged so that both barrels could be released simultaneously by a tripping device.

The means for supporting the pipe from the barrels consisted of a sling of 12-gage annealed wire whose ends terminated in 1½-in. iron rings slipped over short lengths of ½-in. pipe. Two runs of the wire encircled each pair of barrels and passed beneath the pipe. The sling was so arranged that the rings would be free to slip off the short pipe when a vertical pipe, acting as a lever, was tripped by a horizontal pull. The levers projected above the barrels and were connected by a rope to shore. Until the morning of the sinking the sling releases were wired up as a precaution against accidental release. When the time for sinking came, the release was wholly successful, all the barrels being freed instantaneously when the trigger-line was pulled. The sling arrangement was developed by O. G. Goldman of the company's engineering staff.

It was believed that the lead-calked joints of the pipe line would permit of sufficient movement to allow the line to straighten out as it entered the water and later to conform to the slight curve of the bottom. This they did. The empty line, with the aid of the barrels, floated just at the surface of the lake. A rope was tied to each truck as it went into the water and as the pipe floated, the truck was hauled ashore and re-used. Only ten trucks were required, the operations being repeated until the desired length of pipe was floating.

The pipe joints were expected to be tight enough to keep water out while the pipe floated so the buoyancy of the line full of air could be utilized. This they did effectively and although a 1-in. pipe was run down inside the sections as the line was floated, the leakage was so small that it was pumped out only once. To prevent danger to the floating pipe line from wind, two rows of piles were put in on either side of the proposed intake location. These were not used, as no wind strong enough to interfere came up during the work.

While the pipe was being run out into the lake, a concrete box or crib was constructed at the water's edge to serve as anchor block and screen support combined. This crib is 12 x 13 ft. in plan and 4 ft. deep. It contained a recess or re-entrant niche for the end of the cast-iron pipe and was balanced by an extra yardage in other parts so as to float on an even keel. Bolts were set in the recess so that an iron S trap could be placed around the pipe to secure it to the crib just before sinking. In the four corners of the crib were concrete blocks with cylindrical chambers to take 14-in. pipes which were to serve as the posts of the superstructure. Brass bolts to which the screen could be fastened were imbedded in the tops of the concrete wall around the recess for the intake pipe and a temporary wooden bulkhead was put in the recess at the point where the intake pipe was to terminate. This



CONCRETE CRIB READY FOR LAUNCHING

bulkhead formed the fourth side of a well 2½ x 3 ft. in plan at the inner end of the recess and approximately in the center of the crib.

When the intake line had been floated to place the crib was launched. This was done by placing timbers against it and jacking it out into the water. While still near shore the 14-in. vertical pipes were put in place ready for filling with concrete. Reinforcing steel had been left projecting into the chambers provided in the four corners of the crib for the vertical pipe, and this steel extended above the tops of the chambers. A reinforcing steel "cage" was made up to slip down inside each pipe and after these were placed the pipes were raised enough to enable workmen to wire the steel of the cages to that projecting from the bottoms of the chambers. When pipes and steel were in place and had been braced together with timber struts and tie wires, asphalt was poured into the recesses around the bottom of the pipes to avoid filling with water as the crib sunk.

The crib was then towed out to place and backed in so that the outer end of the intake pipe entered the recess and was butted up against the timber bulkhead of the central well. The pipe was strapped to the crib to hold it in place and concrete was poured around the end of the intake pipe so that it was imbedded in a solid concrete block filling the space in the recess

around the pipe but leaving the tops of the walls of the central well free as a base for the screen.

After allowing the concrete to set for one day, the wooden bulkhead which had served as a form was cut out and the wooden plug was removed from the end of the line, leaving the intake ready for sinking. Two 3-in. pipes had been cast in the bottom of the crib. These pipes were capped but care was taken to see that the caps made an easy fit. When ready for sinking the caps were removed and as the crib began to submerge, the barrels were released so that the whole line would sink at the same time. The sinking operation was a complete success. The shore end of the pipe had been left on the trucks so that it could move if any strain was put on it. This was a needless precaution, however, as the pipe did not move at all.

With the anchor block on the bottom of the lake the 14-in. pipes extending upward from it were trued up and filled with concrete, the stay wires were drawn taut and a timber superstructure was built up with a platform level about 12 ft. above the tops of the piles. Working from this platform four guide rods for the cylindrical screen were "fished" into place. These rods or bolts, which are 20 ft. long and 2 in. in diameter, have threads tapped into the lower ends to fit over the ½-in. brass bolts left projecting from the concrete of the central well walls. These rods were readily screwed into place and when the screen was being lowered, fitted into notches cut in the flanges of the screen and guided it accurately to the desired seat over the central intake well.

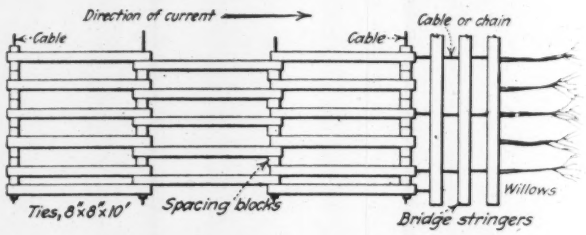
As a final operation, the crib was filled with sand to increase its weight and stability. The sand was brought out on a scow and shoveled into a 14-in. pipe used as a tremie.

Zoning Ordinance for Atlanta, Ga.

The zoning ordinance passed by the City Council of Atlanta, Ga., on April 11 by nearly unanimous vote, establishes four use and three height districts and has lot area requirements in addition. The use districts are for dwelling houses, apartment houses, business and industrial purposes. The building height limit for the three districts are 50, 100, and 150 ft. The basis for lot area requirements is the number of housekeeping units for which the residence building is designed. For much of the dwelling house area 5,000 sq.ft. of lot area per family is required and for sections suited to double or two-family houses, 2,500 sq.ft. per family is required. In apartment house sections, only 625 sq.ft. per family is made necessary, and in the limited hotel and elevator apartment sections there is no minimum lot area requirements, but side, rear and front yards are necessary. The zoning plan and ordinance was prepared for the City Plan Commission of Atlanta by Robert Whitten, city planner, Cleveland, Ohio. Mr. Whitten started his zoning studies in May, 1921, and the zoning ordinance became effective in April, 1922. During this period, Mr. Whitten states, "The initial indifference or opposition of the public was overcome by an intensive educational campaign in which newspaper articles, editorials and cartoons played an important part." In addition, 5,000 copies of a tentative zoning map, together with a descriptive illustrated pamphlet, with the reasons for zoning stated, were circulated.

Missouri River Bank Erosion Checked by Rafts of Bridge Ties

EMERGENCY current retards consisting of rafts of bridge ties, with willow screens below the downstream side to cause the deposit of silt, were employed to check erosion on the east bank of the Missouri River, in 1920, when erosion threatened the Chicago, Burlington & Quincy R. R. near Folsom, Iowa. This construction was a modification of the retards composed of anchored trees, as used elsewhere on the river and described in *Engineering News-Record* Oct. 5, 1921. The raft system was adopted in this case owing to the scarcity of trees in the neighborhood and the urgent necessity of providing immediate protection. Mattress work placed along the bank had proved ineffective owing to undermining of the toe.



RAFT TO CHECK RIVER BANK EROSION

Three rafts were used, 200 to 400 ft. long and about 1,250 ft. apart, extending out from the shallower water along the bank. Each was about 27½ ft. wide, being composed of three rows of 10-ft. ties, 8 x 8-in., having a hole bored near each end so that they could be strung on four ¾-in. wide cables, as shown in the accompanying drawing. The ties were spaced 24 in. c. to c. by means of blocks, which also were bored for the cables. Diagonal lines of cable laid across the raft and stapled to the ties maintained the raft in its rectangular form. Each raft was anchored by cables to concrete piles about 100 ft. upstream and spaced about 110 ft. apart, these piles being sunk till their heads were below the river bed.

To the downstream end of the retard were attached three rows of bridge stringers about 2½ ft. c. to c. and having willows attached to the outer stringer, as shown. As these willows soon began to hang down in the water, due to the sand accumulating on their leaves and boughs, they caused rapid silting beneath the floating retard or raft. A willow fence was built across a strip of low marsh land between high ground and the shore end of the retard in order to prevent water, backed up by the retard, from finding a course across this low land. The fence, formed by two rows of willows about 2 ft. apart, was buried during the first year, the depth of filling amounting to about 4 or 5 ft.

This shore protection proved successful and the fill, which is 6 or 8 ft. above normal water level, was utilized for farming during 1921. Work is to be continued for about three miles downstream in 1922. Portions of the rafts were salvaged in 1921, for use elsewhere, if necessary, but the remaining parts were so buried in the silt that it was impracticable to remove them.

Retards of the tree type are considered generally preferable to the rafts on account of ice conditions in the river. Ice floes would probably break or carry away

rafts, in spite of anchorages. But with trees pointing downstream and having their trunks anchored to the bottom and partly buried in silt, the ice floats over the boughs at the surface. Further, the trees practically fill the space from the river bed to water surface and thus cause more extended silting than the surface raft with willow screen. Both the raft and tree retards mentioned were designed and built by the Woods Brothers Construction Co., Lincoln, Neb., of which Wayne Pringle is chief engineer. The work was done under the direction of A. W. Newton, chief engineer of the Chicago, Burlington & Quincy R. R., and C. L. Persons, assistant chief engineer.

Causeway Succeeds Lynn Floating Bridge

DURING the past year the old "floating bridge" over Glenmere Lake on the line of Western Ave., Lynn, Mass., formerly the Salem Turnpike, was replaced by a new structure. Both the floating bridge and its successor are interesting in type. Notes on their construction are given below, from an account of the county engineer, R. R. Evans, of Salem, in his 1921 annual report, just published.

Dating back to the early part of the past century, the floating bridge, whose final stage of development produced the typical cross-section shown in Fig. 1, "was the solution by the early builders of the problems confronting them at the beginning of the nineteenth century in laying out the Salem Turnpike from Salem to Chelsea Bridge." It crosses the small lake, about 500 ft. wide, although a deviation of 1,000 ft. would have taken the road around the lake. The lake is nowhere more than 10 or 12 ft. deep, but its bottom is mud to a maximum depth of 30 ft. Probably for this reason the bridge was originally built as a floating structure. In recent years only the upper part floated, it is believed.

Mr. Evans considers that probably the two courses of logs at the bottom, the 6 x 6-in. longitudinals and the

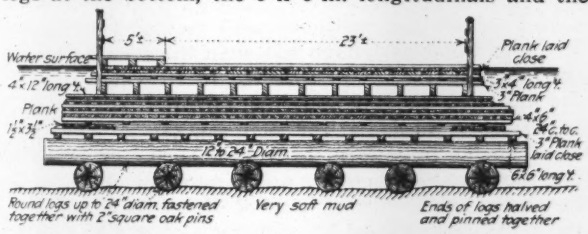


FIG. 1. CROSS-SECTION OF "FLOATING BRIDGE" OVER GLENMERE LAKE, LYNN

3-in. transverse planks constituted the original bridge, and that the timber above this point was added later, from time to time. The depth of the structure as it existed in recent years would bring the bottom just about to the mud line at the deepest part of the lake, while near the shore the logs were undoubtedly buried in the mud. It is believed that only a few of the upper layers of the structure floated in recent years. That some of the structure floated was indicated by undulations in the bridge whenever loads crossed, the water coming up onto the roadway around the load. But in the removal most of the logs of the lower part would not float, while the whole top portion of the bridge could be removed intact and floated off.

For the new bridge a masonry-walled solid-fill on submerged timber trestle was adopted (see Fig. 2). The substructure has bents 7 ft. apart, the piles being cut off and capped with 12 x 14-in. caps. The deck over these consists of 6-in. longitudinal timbering, edged on each side by two heavier timbers notched into the cap to hold the sidewalls more securely. The side walls, 6 ft. high, or 4 ft. above normal water level, have a construction joint at each bent.

It is believed, says Mr. Evans, that this type of structure is best adapted to the conditions encountered, since it should be permanent, is probably less expensive than an earth fill, and avoids settlement as well as heaving of the bottom.

For the work of removing the old bridge and building the new, the lake was pumped down 5 ft., bringing it

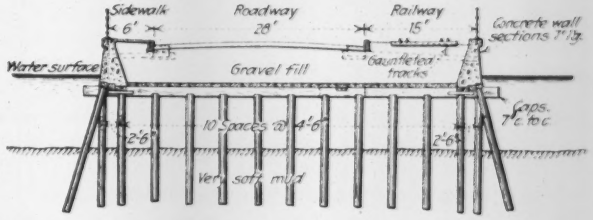


FIG. 2. SECTION OF NEW GLENMERE LAKE CAUSEWAY

about 2 ft. below the deck of the new structure. The old structure was removed by taking out the upper parts of the timber work by a derrick working from each end, and blasting out the lower part by dynamite placed in the holes drilled in rows across the bridge. Only so much material was removed as would interfere with the new structure.

The cost of the work was about $105,000, of which nearly $20,000 was paid by the trolley company for whose use the westerly 18-ft. width was provided. T. Stuart & Sons Co. were contractors.

New York Highway Types

There are only two general types of pavement—concrete and bituminous macadam—which are being constructed in New York State in any considerable amounts, according to the 1921 annual report of Herbert S. Sisson, state highway commissioner. Of all highways constructed this year 56 per cent have been of the concrete type and 44 per cent of the bituminous macadam type. Before a determination was made on any contract as to type a study was made of the local available material, general traffic conditions, relative importance of the highway, soil and frost conditions affecting a rigid pavement, and character of the country through which the highway passed. Comparative estimates in each case were prepared in connection with other data at hand before making a determination. Generally speaking, where satisfactory local stone was not available, the concrete type was adopted on account of the smaller amounts of material to be imported. Where local stone was available in ample quantities on routes of secondary character, bituminous macadam was usually selected of a thickness of approximately two and one-half times that of the concrete.

A Challenge to Accepted Theories of Highway Finance

Fifty-Year Bonds Advocated on Assumption that Roadbed Is Permanent and that Maintenance Includes Resurfacing

By Robert Murray Haig, Ph.D.

Professor, School of Business, Columbia University; Secretary, Special Joint Committee on Taxation and Retrenchment of the Legislature of the State of New York

THE demand for more and better highways arising from the great increase in motorized traffic during the past few years has resulted in a financial problem so great as to make imperative a critical re-examination of the accepted theories of highway finance. Few realize that our states and localities are now spending most of their money for two purposes—roads and schools. There seems to be almost no limit to the need for additional funds for these two purposes alone. Our theory of finance with respect to roads must be developed and refined if the necessary road support is to be secured and if serious consequences to the motor vehicle industry, to the taxpayers and to the community as a whole, are to be avoided.

Many leaders are beginning to appreciate the truth of these statements and the importance of the situation. During the past few weeks an attempt has been made to secure from students of the problem a sharper definition of the questions which must be answered. Various highway engineers, tax experts and others have been consulting as to the possibility of securing a correct analysis of the problem and a sane program of finance. It is the purpose of this article to set forth some of the questions which have been raised and some of the tentative conclusions which have been reached in the hope that discussion may be stimulated and progress made toward a revised and more scientific theory of highway finance.

There appear to be two fundamental questions. The first relates to the division of the cost of supplying highway facilities as between present taxpayers and future generations. To what extent shall the roads be paid for by taxes and to what extent by bonds? The second relates to the division of the cost as between users of the road and taxpayers in general. To what extent shall the roads be paid for by motor car fees or gasoline taxes and to what extent by the general tax levy?

If it is possible to arrive at the correct answers to these two questions the problem is solved. But the correct answers involve a combination of engineering knowledge and sound economic analysis.

1. *Cost Division Between Present and Future Generations*—Certainly the present taxpayers want good roads. They want and they deserve as many good roads as are economically justifiable. But how much of the cost of a good road may fairly be charged to the present generation and how much to the future? If the present generation pays the entire cost of all the roads built it is obvious that fewer roads can be built than if a portion of the cost were met by the proceeds of bonds. But just how much of the cost may be bonded in a sound and defensible financial program for roads?

The general answer is simple enough. Any debt which the present generation passes on to the next must be adequately covered by sound assets passed on to that generation. That is the theoretically correct answer. In general each generation should pay its way. This is axiomatic.

However, when one examines the current applications of this axiom, he finds much bungling because of inadequate analysis of the facts. Consider what the chief of the U. S. Bureau of Public Roads, Thomas H. MacDonald, says regarding one such case of bungled application:

"We have had it imposed upon us almost as a commandment that *'Thou shalt not build a road which will not last longer than the life of the bond.'* Granted. But is the life of the road merely the life of the surface? Because a highway surface goes to pieces are we to conclude that the entire investment in the highway has been lost? To take a specific case:

"The State of New York has issued road bonds for about $100,000,000 and I have seen within very recent times articles written in which it is said that the roads are going to pieces so badly that they will be gone before the bonds have been paid. Probably the road surfaces built with the proceeds of those particular bonds will be gone before the bonds are paid. But it is a fact that this year in New York State we (the Bureau of Public Roads) in co-operation with the state are widening those old macadam roads with 18 ft. of concrete, leaving a strip of the old macadam in the middle. This work has only just begun but successfully so, and the result is a 24-ft. surfaced roadway in place of the old 12- or 14-ft. macadam surface on the same roadbed that was built with the bond money and at a cost which is enough less than the average cost of the new construction of concrete 18 ft. wide to absorb the first cost that the state has invested.

"In other words, so far as I can see it, New York State by the investment of $100,000,000, and by building cheap roads when her needs were for cheap roads, has been having the service of those roads all these years at not to exceed the interest cost and has all the investment left.

"So it is apparent that we must learn to differentiate between the permanent and transient features of the road. In fact, while we expect the surfacing to wear with use, we have perhaps overlooked an actual increment in value in the permanent investment as the years go by. In other words, the subgrade is better as it becomes compact, the bridges are improved, the hills are cut, the safety factors are strengthened and railroad grades eliminated. Use of the road may deteriorate the surface; it only enhances these other factors. It is because of this attention to the subgrade that the old roads of Rome and France are still in use today."

Mr. MacDonald's conclusion that "we must learn to differentiate between the permanent and transient features of the road," based as it is upon the extensive surveys of the Bureau of Public Roads in New York, California and elsewhere, gives a dependable engineer-

ing answer to the economist's query regarding the soundness of the asset which may properly be passed on to the next generation. It holds forth a hope of determining in a fairly definite and precise way what each generation must pay if it is to "pay its own way."

New Definition of Maintenance—It is suggested (The writer desires to disclaim any personal credit for this suggestion but wishes to register his belief in its soundness. It is the result of much discussion to which the writer contributed far less than many others.) that a good method of meeting the problem of differentiating "between the permanent and transient features of the road" would be to establish a new and broader definition of maintenance. If maintenance, to be cared for by the present generation, were so defined as to include not merely day-to-day and year-to-year expense of keeping the highway in serviceable condition but also the replacement of the surfacing when needed, the road would never wear out, but would be turned over to the next generation with its value unimpaired. A road once built to a given standard would be "maintained" for all time to that standard, each generation assuming responsibility for preserving the soundness of the asset during the period it used it. It would appear reasonable to classify as "permanent features" such items as grade reduction, new drainage structures, new alignment and the excess cost of replacing an inferior surface with a superior type. However, if a hard surface be replaced by a new hard surface of the same class the entire cost of replacement would be charged to maintenance or current expense as a transient feature.

Such a definition of maintenance of course destroys the foundation of the standard argument against long-term bonds for highway construction. The life of the road is indefinitely long.

The argument thus far, however, ignores the possibility that, in the far-distant future, roads may not be so useful to society as they appear to be to the present generation. Consequently caution dictates the amortization of the entire road cost over a reasonably long period—perhaps 50 years.

It appears, then, that by the adoption of a definition of maintenance such as that suggested above, the entire original cost of a road might conceivably be bonded on a basis of perhaps 50 years. The theoretical minimum which might fairly be charged against the present generation would then be the sum of (1) an adequate maintenance allowance, (2) interest on the bonds and (3) an amortization item sufficient to retire the bonds in 50 years. The theoretical maximum which could properly be passed on to the next generation would be the bonded indebtedness, reduced by the amount of the accumulated amortization items, against which would exist the roads themselves in a condition as good as when originally constructed.

It must be borne in mind that the above analysis deals with a theoretical maximum and minimum. If space permitted it would be pertinent to discuss the advantages of departing from those limits in rich communities as compared with poor communities and in communities with a bright outlook compared with communities whose "futures lie in their past."

2. *Cost Division Between Road Users and General Taxpayers*—Irrespective of whether the above analysis or some other is finally accepted as the proper one for determining the portion of road costs which shall be absorbed by the present generation, the question remains as to how the cost to be currently absorbed shall be distributed as betwween the user of the road and the general taxpayer. The analysis given above is very suggestive, however, in the search for a solution of the second question.

Motor vehicles as a test of general taxpaying ability have obvious disadvantages and although many states continue to tax them as personal property the trend is definitely away from this practice. Motor vehicle taxes are coming more and more to be pure efforts to measure the use of the roads.

It is also true that while motor vehicles are not the sole users of the road they are usually the only users to be subjected to a special tax. There is some justification for the practice of confining the taxes to the motor vehicles in the fact that the additional road costs which are the occasion of the present difficulties are demanded by the users of motor vehicles alone.

The recent report of the New York State Special Joint Committee on Taxation and Retrenchment contains the following clear analysis of the theoretical problem involved in determining these additional costs. (Report submitted March 1, 1922, pages 132-134. Copies of this report can be secured by addressing Senator Frederick M. Davenport, State Capitol, Albany, New York.)

"The question arises as to whether the whole cost or only a part, and, if only a part, precisely what part, of the costs should be borne by the user.

"Some of the enthusiasts for heavy motor fees seem to forget that roads and streets were considered necessary before the advent of the automobile and the truck and that the public's interest in these roads and streets was often considered sufficient to justify their construction and maintenance as a general public charge. In the case of city streets, of course, it has been a general practice to charge a portion of these costs to the land immediately served, in the form of special assessments. . . .

"On the other hand, some of the representatives of the motor vehicle interests go to the other extreme, asserting that the public builds roads for itself, free for all to use as they choose, and that it is unfair to charge any part of the cost to any particular group of users.

"It seems to the committee that the true view is one which lies between these extremes. That there is a general public interest in the streets and highways is true, but it is equally true, that when these streets and highways cost more than they otherwise would because of the necessity of supplying accommodations to a particular group of users, such additional cost may be properly chargeable to those particular groups. The problem is to draw the line.

"In cases where the roads are used for business the term 'user of the road' must be understood to be the person for whom the service is rendered. . . . A charge on the user of the road would under the present system be imposed, of course, upon the truck, but it will appear as a business expense of the truck owner, who must pass it on in higher prices to the consumer. . . . If the true costs of truck-borne eggs [for example] including the cost of supplying any additional road facilities involved in the use of the truck, is not charged to the buyer of that egg, the egg carried by the railroad is discriminated against, for it must cer-

tainly be sold at a price which covers the entire cost of its transportation. . . .

"The conclusion is that only by charging to the user of the road the community costs involved in supplying him the additional road facilities required by him in his use of the roads can the motor truck competition with the railroad be placed on a basis which will insure an economically sound decision in the struggle between the motor truck and the railroad. This is the only way to keep the account straight, so that an industry whose proper development means so much to the solution of the transportation problem may be neither repressed or unconsciously subsidized."

Charges on the user of the road rest on the benefit principle of taxation. They attempt to apportion the costs as accurately as possible and to ask the person who desires the direct benefit to meet the cost which his use of the road entails. The advantage from the point of view of persuading taxpayers to support a program of road improvement in times of financial pressure like these lies entirely with the plan of imposing charges on the benefit principle rather than on the principle of 'ability to pay' which is depended upon to justify general taxation. Under the benefit principle the man pays directly for what he gets and can readily compare the cost he pays out and the benefit received.

The recent traffic counts indicate that the main roads in many sections are being almost monopolized by motor vehicles. This raises the question as to *whether the entire cost of maintenance as above defined might not be fairly charged to the user.*

The portion of the interest and amortization charges which the user should assume constitute the nub of the tax problem in this field. Much can be said in defense of the assumption that the roadbed would be necessary irrespective of motor traffic and that *the maximum part of the capital charges which may be fairly imposed upon the user would be the portion which the cost of the special surface bears to the entire cost of the road.* This figure could be readily determined.

Conclusion—The above discussion is far from exhaustive. However, it is hoped that even though the constructive suggestions do not win general assent, the analysis may stimulate discussion which will lead to a more rational system of highway finance—one which will build roads as quickly as economically desirable—and not more quickly—one which will not unfairly repress nor yet subsidize the automotive industry—and one which will distribute the tax burden fairly.

Large Railway Gasoline Motor Car

A LARGE steel double-truck gasoline motor car for railway service has been built recently to provide greater accommodation than the small cars now in operation on several railways, and to meet a preference of railway officers for cars mounted in the usual way.

An entirely new design was made for this car, which is not a converted motor truck. It is 42½ ft. long over all, 8 ft. 4 in. wide and 10 ft. 8 in. high over the ventilators, with a weight of about 13 tons. Steel is used for the framing, with ⅜-in. side plates up to the level of the windows. A rear vestibule forms the entrance to the main compartment, which has seats for 38 passengers; drop seats in the baggage room increase the seating capacity to 46. A 60-hp. engine drives both axles of the leading truck. In trial runs on the Cleveland, Cincinnati, Chicago & St. Louis Ry. between Wabash and Milford, Ind., a round trip of 92 miles, the normal speed is 37 m.p.h., with a maximum of 48 m.p.h. The car will make about 30 m.p.h. on a grade of 1 per cent. During these runs the car has averaged 5.3 miles per gallon of gasoline.

DOUBLE-TRUCK GASOLINE CAR FOR RAILWAY WORK

This new car, built by the Service Motor Truck Co., Wabash, Ind., is a development from a four-wheel 32-passenger car which was built by the same company and has had a year of successful operation on the Winchester & Western R.R. (see *Engineering News-Record* of April 14, 1921, p. 648). The smaller car, with a daily run of 90 miles, has an operating cost of about 10c. per mile, according to C. H. Sencindiver, general manager of the railroad. The daily cost is as follows: Crew, $5.80; gasoline, $2.40; oil, 15c.; repairs, etc., 50c.; total, $8.85. A light trailer is hauled for carrying express. The line has 4 per cent grades and 16 degree curves. The schedule speed is 25 to 28 miles per hour.

Ten Tests of an Efficient Assistant

Engineers in executive positions who may have occasion to sum up in concise form the qualities they seek and value in subordinates will be interested in the following list on which British Civil Service employees are rated for promotion: 1. Knowledge of department (or branch). 2. Personality and force of character. 3. Judgment. 4. Power of taking responsibility. 5. Initiative. 6. Accuracy. 7. Address and tact. 8. Power of supervising staff. 9. Zeal. 10. Official conduct.

Diesel Engines To Furnish Power For Water-Works

New Station at Gloucester, N. J., To Be Equipped with Motorized Pumps and High-Economy, Oil-Engine-Driven Generators

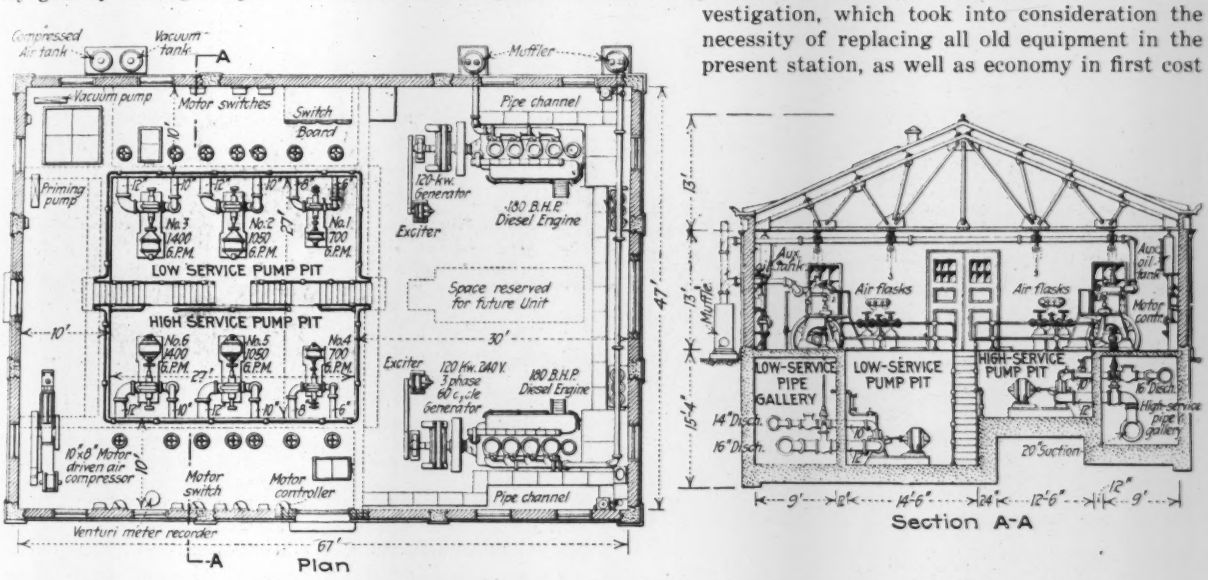
By W. DeWitt Vosbury
Of Remington & Vosbury, Consulting Engineers, Camden, N. J.

DIESEL-ENGINE-DRIVEN generators will be used to furnish power for the electrically-operated pumping station now under construction at Gloucester, N. J. The present plant was built in 1883. It is steam-driven and has for its source of supply a number of wells varying in depth from 100 to 500 ft. Water is raised from the wells by an air-lift system and conveyed to a small receiving basin, from which it is pumped by low-service, direct-acting pumps to two elevated settling tanks. After settling, the water flows by gravity through rapid sand filters to a large clear-water reservoir, from which it is pumped by two 2-m.g.d. horizontal, crank-and-fly-wheel pumping engines into the distribution system. Sedimentation, followed by filtration, is necessary to remove the iron with which the water is impregnated.

Some two years ago it became evident that radical alterations and improvements were imperative. Most of the equipment was badly in need of repair or replacement and the water supply was inadequate. In addition, the operating expenses were excessive, due to the fact that all water was pumped three times: (1) by air-lift from the wells to the receiving basins; (2) from the receiving basins by low-lift pumps to the settling tanks and filters; (3) from the clear-water reservoir to the distribution system. It was clear that any general scheme of improvement should first recognize the necessity of an ample supply of water, and second, the elimination of at least one of the three pumpings and a reduction in operating expenses.

The water supply was first investigated by the construction of four 8-in. wells, by a method not previously employed at this particular well field. The results obtained were so successful that the 18 original wells were abandoned and the four new wells only continued in service. Furthermore, it was determined by a series of careful tests, that, with six to eight wells of the new type, it would be entirely feasible to pump all water required for years to come by direct suction at a maximum draft of not to exceed 30 ft. below the present engine room floor.

It was decided to lift the water directly from the wells to the filter plant by pumps, installed in a suitable pit, thereby eliminating one of the three pumpings and at the same time the use of compressed air. Owing to the depth of the pit required, it was desirable to keep the pit as small as possible, to avoid excessive construction costs. For this reason, the use of steam-turbine-driven centrifugal pumps was first contemplated, but later abandoned, as it was found that, owing to the low power requirements of the pumps, it was not practicable to run the turbines with condensers and they would, therefore, be inefficient. Further investigation, which took into consideration the necessity of replacing all old equipment in the present station, as well as economy in first cost and efficiency in operation, led to the decision to construct a new station using electrically-driven pumps.



ELECTRIC-DRIVEN PUMPS AT GLOUCESTER, N. J., WITH GENERATORS DRIVEN BY DIESEL OIL ENGINES

The new station will have two sets of motor-driven centrifugal pumps, one for low service from the wells to the filter plant and the other for high service from the clear-water reservoir to the distribution system. Each set consists of three pumps, having capacities of 700, 1,050 and 1,400 g.p.m., respectively. The various combinations of these capacities will give pumping rates of from 1 to 4.5 m.g.d. at intervals of 0.5 m.g.d.

Both sets of pumps have been placed in the pit, which is 27 ft. square in plan and of two depths, the deeper half being occupied by the low-service pumps. On each side of the pit is a pipe gallery of sufficient space to accommodate and conceal the rather complicated piping required by the fact that the two larger units of each set are interconnected so that they may be operated in series as well as in tandem.

As previously stated, the current for operating the pumps will be furnished by either of two generating sets. Each unit will consist of a 120-kw., 240-v., 3-phase, 60-cycle generator, direct-connected to a

180-hp. vertical, four-cylinder, Busch-Sulzer, 300-r.p.m. diesel oil engine.

Current from the main panel board will be distributed through concealed conduits in the pipe galleries to the pump, motors and controllers. The latter will be attached to the walls on the ground floor, directly opposite the pumping units which they control. In starting or stopping the pumps it will not be necessary for the operator to descend into the pit.

In all ground waters there is more or less entrained air, which is released as soon as the pressure is relieved. Since the action of centrifugal pumps is particularly sensitive to the presence of air, even in small quantities, provision has been made for the trapping and removal of the air before the water reaches the pumps. At the point where the suction main enters the pipe gallery will be located a large, vertical, steel tank, through which all water from the wells must pass. This tank, with the aid of suitable baffles, will serve as an air trap. Located on the outside of the building and connected to the trap will be a large air receiver in which a constant vacuum will be maintained by an automatically-controlled, motor-driven, vacuum pump. Besides the vacuum system, there will be a special priming pump capable of exhausting the air rapidly from the pumps and suction mains whenever required. Provision for priming by water under pressure will also be made.

In addition to the equipment already mentioned, a 10 x 8-in. single-stage, motor-driven, air compressor will be used to furnish air under pressure for cleaning the wells. For the purpose of keeping complete daily operating records of the station, suitable instruments will be installed to record the quantity of fuel oil consumed by the engine, the current used, suction lift, discharge pressure and gallons pumped.

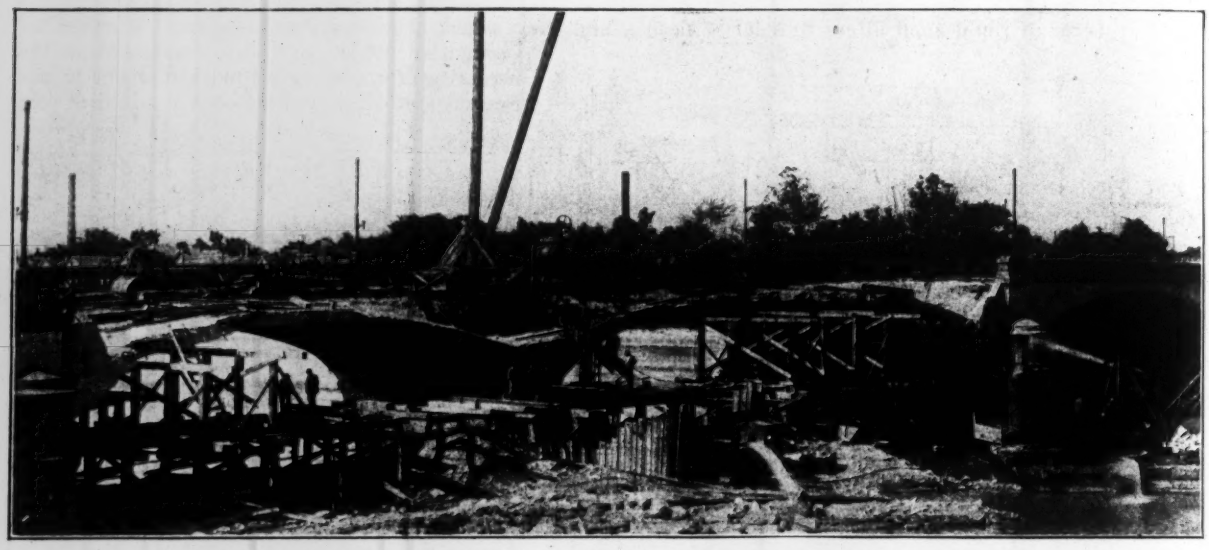
Upon completion of the new station, the equipment in the old building will be removed and a new, rapid sand filter plant installed.

The old station is now operating at the rate of approximately 2,000,000 m.g.d. In 1921 the cost of operation, including fuel, labor, repairs and miscellaneous items of expense, was $0.0577 per 1,000 gal. of water delivered to the distributing system. Based upon the guaranteed fuel oil consumption of 0.48 lb. per b.hp. hour and 0.6 gal. of lubricating oil per 1,000 rated hp.-hours, with liberal allowances for labor, repairs, supplies and miscellaneous items of operating expense, the estimated cost is $0.0290 per 1,000 gal. of water pumped, or an expected saving of fifty per cent.

Timber Struts Under Compression Take Arch Thrust During Bridge Repair

By Fred M. Hall
Dayton, Ohio

A NOVEL method of counteracting the thrust of spans adjacent to the area to be repaired was employed during the reconstruction of the Third Street bridge in Dayton, Ohio, which failed in an unusual manner in February, 1921. Details concerning the failure and the proposed repair were contained in *Engineering News-Record* Feb. 10, 1921, p. 264, and March 24, 1921, p. 511.



A DETAIL IN THE RECONSTRUCTION OF THE THIRD STREET BRIDGE, DAYTON, OHIO

Four lines of timber struts, placed under 75 tons compression by hydraulic jacks, were built to relieve the damaged spans of the arch thrust of adjacent spans.

The method of repair planned by the consulting engineers consisted in unloading the spans at either side of the two which failed down to the arch rings in the upstream section, to cut the remaining portions of the arch rings in the spans that failed and to remove from the river channel a part of the pier that had broken off and all of the collapsed portion of the arch barrels. The plans also called for a new pier to be set 3 ft. deeper than the old one.

To carry out these plans a steel sheetpile cofferdam was sunk, enclosing the broken-off pier with the south wall, following the line of fracture. This south wall of the cofferdam acted as a cutoff wall between the part of the pier that had broken off and the good part which remained. The wall was sunk as the excavation in the cofferdam progressed and was left in place when the new pier footing was poured, the top part only being cut off.

In order to take the thrust of spans 1 and 4 (the spans at either side of those two that failed) against piers 1

and 3 (see accompanying photograph), four lines of struts 200 ft. long and extending from the springing line of pier 1 to the springing line of pier 3, were placed, with 75 tons compression in each line of struts. Piers 1 and 3 were first unloaded of pavement and spandrel filling down to the arch rings. The four lines of 12-in. x 12-in. timbers were constructed on falsework bents 10 ft. apart, bolted in perfect alignment and painted. The 75 tons pressure was secured by hydraulic jacks.

At a given point in each line of struts a 3-ft. section was left out and heavy cast-steel shoes were placed on the ends of the struts facing each other. These shoes extended beyond the strut on each side to provide bearings for the jacks. Two 60-ton hydraulic jacks were then inserted and when a pressure of 75 tons was reached, a 12-in. x 12-in. hardwood strut was sawed the required length and driven in between the shoes in alignment with the struts. The jacks were then released and moved over to the next line of struts and the operation was repeated.

The struts extended across pier 2 above the cofferdam. They were boxed in and concrete was poured around them during the pouring of the pier shaft. After the arch barrels had set, the struts were removed and the holes through the pier shaft were filled with concrete. Care was exercised during construction to protect the struts from falling material or from any jar which might affect their alignment.

The work was in charge of George F. Baker, city engineer, and the writer was resident engineer. Glen M. Wiley, Tippecanoe City, Ohio, the contractor, personally supervised the reconstruction.

Advocates Four-Inch Brick Walls

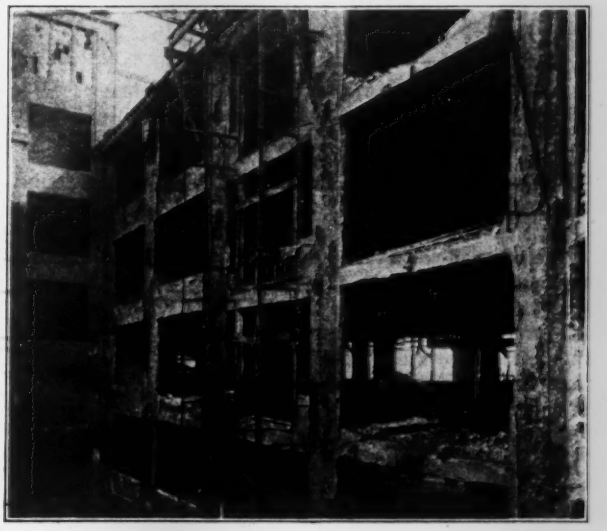
Four-inch brick walls for both bearing and non-bearing partitions were advocated by William Carver, architect of the Common Brick Manufacturers Association, in a paper read at the Building Officials Conference, Indianapolis, on April 25. Mr. Carver said that such walls are considered standard construction in Europe, that in England more than 90 per cent of all houses erected are built with 4-in. interior bearing partitions, and that 2½-in. partitions, built of brick laid on edge, are extensively used there for non-bearing purposes. Tests made by an English building materials research committee were quoted to show the strength of such construction. They were made on 4-in. and 2⅝-in. walls, and included tests of pillars 14 in. wide and 42-in. lengths of wall, both 8½ ft. high, the pillars being tested under vertical load only and the wider sections under a combination of vertical load and horizontal pull at mid-height. The ultimate strength of the 14-in. pillars was found to be about two-thirds of the crushing strength of 9 x 9-in. cubes, ranging from 330 to 1,040 lb. per square inch for the pillars as compared with 720 to 1,530 lb. per square inch for the cubes. In the case of the 42-in. walls under a load generally of 3½ tons, a horizontal pull of 375 to 895 lb. at mid-height was required to break the wall. The low result in each case was found for a 4½-in. wall laid up in lime mortar. The 2⅝-in. wall, laid up in 1:3 cement mortar, gave results barely inferior to those found for a 4½-in. wall, namely, 1,040 lb. per square inch crushing strength on the 14-in. pillar, and 553 lb. horizontal pull required to break the 42-in. section of wall under 3½ tons load. All the tests were made at about one month age.

Germans Learn Lessons from First Concrete Building Fire

Combustible Contents Destroyed Because of Poor Fire Protection—Concrete Structure Stands Up Well

IN THE complete destruction of the contents of the factory buildings of the Sarotti Co. in Berlin, Germany, last January and the severe damage to the concrete structures German engineers have had their first experience with a severe fire in a large reinforced-concrete building. As a result they have learned a number of lessons regarding the necessities of fire protection in what has been assumed to be a completely fireproof structure and have had confirmed their faith in the fire resistance of well made reinforced concrete.

The building in which the fire took place was five stories high, a beam-and-girder reinforced-concrete building of an outside plan area of 255 x 180 ft. with an interior court about 50 x 70 ft. Each of the five floors was open and all were connected by staircases on the interior court, well protected against the floor itself but with only plain glass windows opening on the court. A basement under the whole structure had skylights opening into this same court.



OPENING ON INTERIOR COURT AFTER FIRE

The building was filled with highly combustible materials, in the basement wood shavings and packing materials, and in the rest of the building mostly chocolate and cocoa beans. The fire broke out in the basement and rapidly spread over its entire area breaking through the skylight into the open court, which formed a chimney carrying the flames up to the exposed windows on each floor. These windows were soon broken through and every floor completely gutted of its contents. So confident were the owners of the fire-resisting qualities of the factory that the workmen were not even called out of the upper floors when the fire was first discovered in the basement, and due to the exposure through the open glass, the fire-escape stairway became impassable and many workmen had to be rescued by the fire department through outside windows.

ONE OF THE FLOORS AFTER THE FIRE
Spiral columns exposed in background; expansion joint open in ceiling.

It is reported that an inspector after the fire found that every single piece of material that could possibly burn in the building had been consumed and that only the reinforced-concrete structure itself remains and this badly damaged in places. The principal damage is of the type shown in some of the views, that is the crumbling off of the outer layers of concrete and the exposure of the steel. So far as has been learned, no complete failure occurred except in one staircase in the basement exposed to the direct play of the flames in the initial fire. It is stated that the columns were in practically every case exposed down to the spiral reinforcement, that the girders more frequently had only a surface spalling, and that the floor itself was quite well protected. The greatest damage was in the top floor which was chiefly occupied by bunkers for storing the cocoa and cocoa beans. Here the concrete was very seriously damaged so that it will probably have to be replaced.

DESTRUCTION ON ONE OF THE FLOORS
Surface spalling apparently only damage here.

A curious phenomenon in regard to an expansion joint is reported by the German engineers. It is stated that there was such a joint across the whole width of the building, about ¾ in. wide and filled with wood. Great alarm was taken during the fire from the fact that contrary to all expectations this joint instead of closing widened, showing an opening of nearly 8 in. running crosswise of the whole building. When this happened the firemen were recalled for fear that the whole building would come down. This contrary behavior of the expansion joint is still a puzzle to all the experts. The wood filling was completely burned out. Many theories have been formed in explanation, the most feasible of which is based on the fact that the butt ends of the joint in the lower floors showed signs which would indicate that the joint there had first closed under pressure. It is being pointed out that the heat in the concrete structure was at first not uniform, spreading from the interior toward the outside and from the lower stories upward. The expansion would, therefore, greatly differ. While a certain warping of the floors may have occurred laterally, it is considered most likely that the expansion joint closed at the lower stories under the first effects of the fire and the expansion allowed thereby being insufficient the direction of the forces was reversed with a tendency to open up the joint in the upper stories.

Registration Urged by Architects

Reporting on an investigation of the collapse of the Knickerbocker Theater roof in Washington, a committee of the local chapter of the American Institute of Architects has recommended compulsory inspection of construction work by the owner and his architect, and followed this by presenting a strong plea for registration of architects. The report is published in the April *Journal* of the Institute.

On the former point, it proposes that the building regulations of the District of Columbia be amended to make it imperative for the owner to employ a competent "clerk of the works" constantly on the building during its construction, this clerk acting under the direction of the architect. His duties would be to check all materials delivered against the drawings and specifications, and to check the quality of the workmanship. It remarks that "the office of the Building Inspector should not be required to maintain a force of inspectors sufficiently large to provide proper inspection of all building operations in the district. This is an entirely unnecessary expense, which expense is not borne by those receiving the benefits." It also comments on the division of responsibility between builder and contractor by stating that the contractor "should not be held responsible for any architectural or structural feature of the design" but should be responsible only for proper execution of the contract requirements.

On the subject of registration, the report says: "Architects without adequate training, draftsmen without any training at all, should not be permitted to practice. The public is paying continually for improper and inadequate advice from men without proper training and experience. The chapter should press with vigor the measure now before Congress providing for the registration of architects. Why should an architect be permitted to practice without proper education any more than a doctor or lawyer."

Anomalous Results in Venturi Flume and Meter Tests

A Discussion of the Peculiar Variations of Venturi Coefficients of Discharge—Wave Formation, Air and Other Theories

By William J. Walker
University College, Dundee, Scotland

THE paradoxical results which frequently occur in hydraulic work, particularly under low rates of flow, are illustrated by the data obtained in the tests of a Venturi flume given in the article by P. S. Wilson and C. A. Wright, in *Engineering News-Record*, Sept. 2, 1920, p. 452. Before attempting to throw some light on questions raised by the article cited a portion of it will first be abstracted from the article mentioned.

H	H_t	C
0.178	0.025	0.983
.112	.010	1.000
.063	.002	1.036
.038	—.002	1.112
.025	—.003	1.211
.017	—.004	1.320
.014	—.004	1.384
.010	——	1.411
.0105	——	1.678
.007	——	1.800

Fig. 1 shows the peculiar and perfectly definite nature of the change which is taking place in the recorded results, the value of C, the coefficient of discharge, being obtained by the application of the orthodox equation

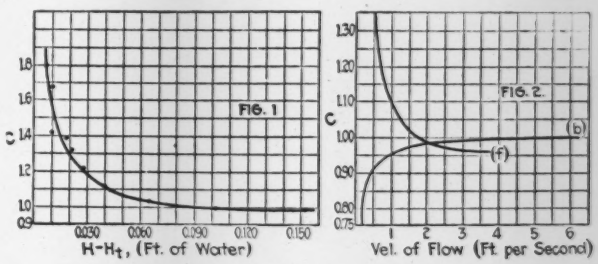
$$C = \frac{v}{\sqrt{2gh/m^2 - 1}} \quad \ldots\ldots\ldots\ldots (1)$$

where v = velocity of water in feet per second and h = pressure difference in feet of water between entrance and throat = $H - H_t$.

A paper by Prof. A. H. Gibson (Proc. Inst. C. E., Vol. VXCIX, p. 392) gives a series of the same type of curves as the above, but for Venturi meter flow. Some of these curves (Fig. 2) show that in certain cases, the results are similar to those of Fig. 1, while the remainder show the exactly opposite tendency, namely a decrease in C with a decrease in velocity of flow. The difficulty of explaining such conflicting results is at once apparent, since any explanation applying to one type of curve obviously cannot account also for the other type. The writer has obtained similar results for many experiments on Venturi meter flow, the type of curve in which the coefficient of discharge, C, increases as the rate of flow diminishes being, for his own experiments, by far the most common.

Several arguments have been advanced by different experimenters to account for such results but no satisfactory explanation has yet been advanced, so that, perhaps, the writer may be pardoned for introducing subject-matter here, which while not professing to solve the problem, may at least offer a clue to its solution.

The anomalous results, as given above, were assumed by the writers of the article in question to be due to wave formation. This, although the evidence of eye witnesses, does not appear very convincing, since at such low rates of flow at which the paradoxical results are obtained, the wave formation set up, if any, would not be very likely to have the effect of increasing the coefficient of discharge, C, as the velocity of flow is diminished. From the brevity with which the difficulty is dismissed, however, it may have been considered that the matter was of little moment so far as the main object of the tests was concerned, and so received little consideration. It is important to note, however, that the results of such flume tests entirely negative an explanation which is commonly advanced with regard to similar Venturi meter results. The explanation in question is based on the fact that meters which give abnormally high values of C at low velocities are invariably working under negative throat pressures. This then, it is claimed, results in the liberation of air at the throat, thus increasing the throat gage reading and so giving a fictitiously high value to C. According to the arrangement of the flume experiments



VENTURI FLUME AND VENTURI METER CURVES

no such explanation is valid, since the throat of the flume is open to the atmosphere.

In the most recent development of the mathematical treatment of fluid motion it is now generally agreed that, based on the application of the principle of dynamical similarity, the resistance to fluid motion may be written (Advisory Committee for Aeronautics (London) 1909-10. "Note on Dynamical Similarity," Rayleigh) in the form:

$$R = \rho v^2 f\left(\frac{m}{vl}\right) \quad \ldots\ldots\ldots\ldots (2)$$

and the general form which is usually given to the function f is such that for any system of fixed dimensions

$$R = Av + Bv^2 \quad \ldots\ldots\ldots\ldots (3)$$

where A and B are constants. Results, however, are frequently obtained which are not amenable to the use of this formula unless the sign of the constant, A, may be allowed to be negative. (Advs. Comtee. 1910-11. See also "Motion of Liquids," p. 178, Villamil.) If such is the case, the only admissable formula which may be applied is

$$R = K + Av + Bv^2 \quad \ldots\ldots\ldots\ldots (4)$$

where A may be positive or negative.

The term K must, of course, be very small but it does not appear to be difficult to imagine it as a resistance force independent of velocity and due to the surface tension and adhesive forces of the fluid at the boundary surfaces. It is not so easy, however, to account for results for which A has a negative value. This constant is usually spoken of as the viscosity constant, and by the definition of viscosity, it cannot have a negative value. To define a property of matter, however, does not necessarily mean that its entire significance has been grasped. The writer is one of those who, although constantly applying the definition to his own experimental results, does so with a feeling of its incompleteness. The object of the present article,

however, is to draw attention to, and emphasize the fact that, granted the reliability of experiments which have given negative values of A, the analytical curves derived from (4), when A is given positive and negative values respectively, are exactly similar to the Venturi meter and flume curves illustrated in Figs. 1 and 2. This analysis is given by the writer in two short papers published in the *Philosophical Magazine* for February and July, 1921.

It will be observed, of course, that fluids behaving according to an equation of type (4) cannot be strictly amenable to Bernouilli's theorem, although under ordinary conditions they may appear to be so amenable. It will be only under certain conditions, such as say, rapid convergence of boundary walls or low velocity of flow, in which the application of Bernoulli's theorem will give the anomalous results so often observed.

Attention is here drawn to a fairly common explanation of these anomalous results, which appears to be based on a misapplication of Bernoulli's theorem. The argument is adopted that for streamline flow the kinetic energy across a section is $\frac{v^2}{g}$ per lb. of water (where v is the average velocity of flow across a section) and not $2g$ as usually applied in the fundamental equation. If, then, it is assumed that there is streamline flow throughout the meter or flume, and the kinetic energy be written $\frac{v^2}{g}$ instead of $\frac{v^2}{2g}$, a value of C is obtained which is in the neighborhood of 0.7, and it is claimed that this accounts for the low values sometimes obtained. The flaw in the reasoning lies in the neglect of any averaging of the pressure energy values also over a cross-section. Bernoulli's theorem is strictly applicable to a single streamline. If it is applied to a series of contiguous streamlines, the kinetic energy of these as carried out above, by averaging the velocities squared, gives a value which is certainly half that of the same number of streamlines of common velocity, v. It cannot be assumed, however, as is implicitly done in the above explanation, that the pressures along the lines would be the same in both cases. If such were so then the only logical conclusion is, that the theorem applies to the fluid in bulk, but does not apply to the streamlines themselves. It certainly cannot apply to both, if v is considered as the average velocity in each case.

In the same way by the assumption that there may be, in certain cases, critical velocity at the throat with streamline motion at the entrance to meter or flume, it can be shown that C may have values slightly greater than unity, although not nearly so high as those which are frequently obtained.

To account for the latter high values, an ingenious, though in the writer's opinion untenable, explanation is given in an article entitled "A New Hydraulic Paradox," published in London *Engineering*, May 27, 1921. In this, these high values of C are attributed to the assumed reversal of the radial velocities of the water particles as they strike the orifice of the pressure-measuring devices used. As such reversal will normally give rise to twice the pressure which would be obtained if the radial velocity of each particle were simply annulled at the wall, then at the throat of a meter, where higher velocities prevail, higher pressure reading discrepancies will occur, and these will result in abnormally high values of C. The objection to this explanation is that water particles, moving in bulk at least, do not behave so that they assume equal and opposite reversal of velocity on impact against a solid surface. Even under turbulent motion conditions, when a high velocity jet of water strikes a flat plate at right angles to the stream, the bulk of the water travels over the surface of the plate and does not rebound (even where the splashing effect is considerable) with anything like equal and opposite reversal of velocity. In the case of the pressure-measuring device, the possibility of reversal of the radial velocity of the particles on the open end of such devices (the impact of water particles on a water surface) would appear to be even less probable.

The writer's own view after deducing the analytical curves based on (4), which curves turned out to be similar to those so frequently obtained, was that the stationary film (if any) of fluid next to the boundary walls might be in some state of fluctuating strain due to periodic breakdown of the film during flow, the action of this film being presumably the hitherto neglected factor in analysis. He has since, however, carried out experiments involving the passage of polarized light both along and at right angles to the line of flow in glass and metal tubes but has detected no state of strain or change of strain, in either case, in the boundary layers. It may be that the effect was too feeble to be observed under the conditions of these experiments. In any case, although this view has, so far, been apparently negatived, the important fact remains that the representation, graphically, of C against head or velocity of flow, as deduced from (4), gives curves similar to those obtained in practice, whereas other theoretical explanations account only for single definitely high or low values of C, and not for values which vary continuously from normal to abnormally high or low values. Although the action which is taking place has by no means been made clear it is hoped that the foregoing treatment of the subject may lead to some further elucidation of the difficulty.

Highway Construction in Britain

(*London Correspondence*)

It is probable that the outlay on British road construction for the year ending March 31 will exceed £50,000,000, as compared with £20,000,000 in the year 1913-1914. On the 23 road schemes originated with the idea of alleviating unemployment the road fund of the Ministry of Transport had provided £1,200,000 in grants and £623,000 in loans. An important feature of these road schemes, both in urban and rural areas, is the width provided. On the majority of these new roads the width between fences is 100 ft. and in some cases it is 120 ft. Says the Ministry of Transport: "The necessity for the creation of many of the by-pass roads now under construction has arisen from the lack of foresight on the part of former generations, who have allowed the roads to be throttled by the erection of buildings unprovided with forecourts and insufficiently set back. This is an ever-present danger and can only be guarded against by the introduction of legislation giving general powers for the prescription along main roads of such building lines as will provide ample scope for future widenings without the prohibitive cost involved in the demolition of buildings."

Largest Storage Reservoirs in the United States in Use in 1920

Compiled by Allen Hazen, Civil Engineer, New York City, for The Committee on Water Supply of Engineering Council

Capacities include only the available capacity ordinarily and easily used and do not include water below the outlet and not available; nor water held above the flow-line by flash-boards unless the flash-boards are a part of the regular equipment and are normally used each year; nor temporary storage at times of high flood.

The information was first secured and verified by a well informed hydraulic engineer in each state selected for this purpose by the council. Figures for several states from which returns were not received have been supplied from any other source believed by the committee to be trustworthy.

As Engineering Council was abolished the work of this committee was terminated while it was still in an incomplete state, and this table represents this particular work as far as it had been then carried.

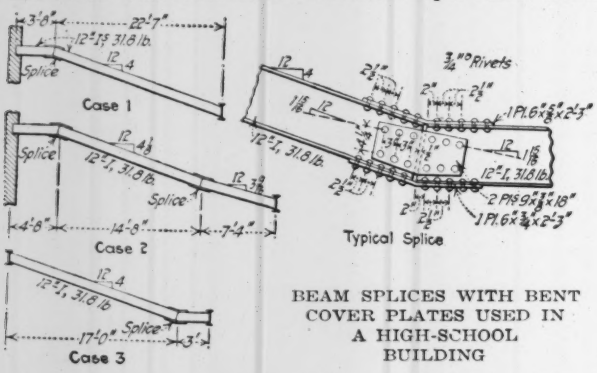
Name of Reservoir	Year Began To Fill	Area Acres	Cap'y Billion Gal.	Depth of —Water, Ft.— Max.	Aver.	Used For
Elephant Butte, N. M.	1915	40,680	863	193	65	Irr.
Roosevelt, Ariz.	1908	.....	425	220	.....	Irr.
L. Winnibigoshish, Minn.	1884	103,040	338	.....	10	Irr.
Pathfinder, Wyo.	1909	.....	327	200	.....	Nav.
Jackson Lake, Ida.	1916	25,530	254	.....	30.7	Irr.
Leech Lake, Minn.	1884	149,760	247	.....	5	Nav.
Moosehead Lake, Me.	.....	74,900	177	.....	7.3	Pow.
Ripogenus, Me	1916	28,800	157	.....	22	Pow.
Clear L. Kla., Ore.	.....	.....	150	.....	.....	Irr.
Shoshone, Ida.	1909	6,604	148	.....	69	Irr.
Ashokan, N. Y.	1913	8,180	132	190	50	W S
Twin Lakes, Me.	.....	.....	123	.....	.....	Pow.
Medina, Tex.	1913	.....	98	156	.....	Irr.
Big Meadows, Cal.	.....	15,500	96	.....	20	Pow.
Bridgewater, N. C.	1919	6,510	94	.....	44	Pow.
Lahonton, Nev.	1914	12,000	94	112	24	Irr.
Arrowrock, Ida.	1915	2,860	91	.....	98	Irr.
Sevier Bridge, Utah.	1908	10,120	82	.....	26	Irr.
Strawberry, Utah.	.....	.....	81	.....	.....	Irr.
Sebago Lake, Me.	.....	28,672	77	.....	8.2	Pow.
Salmon, Ida.	1911	3,500	74	120	65	Irr.
Azicohos, Me.	1913	.....	71	60	.....	Pow.
Lake Kachess, Wash.	.....	.....	68	.....	.....	Irr.
Magic, Ida.	1911	3,800	65	.....	52.5	Irr.
Belle Fourche, S. D.	1910	8,000	65	100	25	Irr.
Mooselookmaguntic L, Me.	.....	16,608	64	.....	11.9	Pow.
Spednic Lake, Me.	.....	14,618	64	.....	13.5	Pow.
Wachusett, Mass.	1905	4,200	63	150	46	W S
Deer Flat, Ida.	1908	9,250	60	.....	20.1	Irr.
Sawyer Lake, Me.	.....	6,720	60	.....	27.3	Pow.
Salmon River, Ida.	1911	3,500	58	.....	53	Irr.
Pine River, Minn.	1886	562	58	.....	3	Nav.
Blewett Falls, N. C.	1912	2,500	57	.....	74	Pow.
Warm Spring, Ore.	1919	4,200	55	.....	43	.....
L. Winnepisaukee, N. H.	1850	45,400	52	.....	4	Pow.
L. Keechelus, Wash.	.....	.....	49	.....	.....	.....
Badin, N. C.	1917	6,500	46	.....	23	Pow.
Croton, N. Y.	1906	3,360	45	157	41	W S.
Richardson Lakes, Me.	.....	8,371	42	.....	15.5	.....
Grand Lake, Me.	.....	15,155	39	.....	8.05	.....
Burton Lake, Ga.	1920	2,200	35	.....	58	.....
Tahoe Lake, Cal., Nev.	.....	120,000	39	.....	1	Irr. & P
Pakegama, Minn.	1884	660	39	.....	19	Nav.
Kensico, N. Y.	1916	2,218	38	155	52	W S
Grand Lake, Me.	.....	15,034	34	.....	7.0	.....
Indian River, N. Y.	1898	5,053	33	46	20	.....
Stanley Lake, Col.	1910	.....	32	108	.....	Irr.
Lake Walcott, Ida.	.....	11,350	31	.....	8.4	Irr.
Chamberlain L., Me.	.....	11,264	30	.....	8.4	Pow.
St. Marys Lake, O.	1841	13,440	30	.....	7	Nav.
Keuka Lake, N. Y.	.....	11,200	30	.....	9	Nav.
Spaulding, Cal.	1914	805	30	.....	83	Pow.
Cimmaron, N. M.	1918	.....	26	.....	.....	.....
Hinckley, N. Y.	1915	2,850	26	.....	29	.....
Lake Cheesman, Colo.	1901	874	26	222	88	W S
Schoomook Lake, Me.	.....	.....	25	.....	.....	.....
Sehee Lake, Me.	.....	7,000	25	.....	11.1	.....
Twin Falls, Ida.	1912	800	24	137	90	Irr.
Oakley, Ida.	1913	1,290	24	.....	57.8	Irr.
Crystal Springs, Cal.	1888	1,500	23	.....	48	W S
Sandy Lake, Minn.	1895	421	23	.....	18	Nav.
Umbagog Lake, Me	.....	10,112	23	.....	7.15	.....
Gull Lake Minn.	1913	22,720	23	.....	3	.....
Lake George, N. Y.	.....	28,000	22	.....	3	Pow.
L. Minatare, Neb.	.....	.....	20	.....	.....	Irr.
Haiwee, Cal.	1911	2,100	21	60	30	W S
Delta, N. Y.	1912	3,070	21	70	23	Nav.
Square Lake, Me.	.....	9,344	20	.....	6.7	.....
Drews, Ore.	1912	4,540	20	.....	14	.....
Somerset, Vt.	1913	1,690	20	.....	41	Pow.
Fort Worth, Tex.	1914	.....	20	36	.....	W S
Piute, Utah	1908	2,300	19	.....	28	.....
1st Conn. Lake, N. H.	1916	2,960	19	.....	21	.....
Cranberry Lake, N. Y.	1867	6,700	19	.....	9	.....
Great Pond, Me.	.....	8,198	19	.....	7.1	.....
Buskahegan Lake, Me.	.....	10,496	18	.....	5.43	.....
Millinocket, L., Me.	.....	8,928	18	.....	6.3	.....
Meddybemps, L., Me.	.....	7,940	18	.....	7.0	.....
Otter Creek, Utah.	1897	.....	17	.....	.....	.....
Big Creek, Cal.	1914	1,554	17	110	34	Pow.
Big Lake, Me.	.....	10,419	17	.....	5.0	.....
Altmar, N. Y.	1913	3,000	17	.....	18	.....
East Park, Cal.	.....	.....	16	.....	.....	Irr.
Syladobsis L., Me.	.....	6,310	16	.....	7.95	.....
L. McMillan, N. M.	1893	5,500	16	.....	10	.....
Eagle Lake, Me.	.....	6,400	16	.....	7.75	.....
Long Lake, Me.	.....	6,112	16	.....	8.0	.....
Cold Spring, Ore.	1908	1,590	15	70	30	Irr.
Ochoco, Ore.	1919	1,220	15	.....	40	.....
Croton Falls, N. Y.	1910	1,600	15	100	29	W S
Morena, Cal.	1911	1,370	15	142	34	W S
Crane Valley, Cal.	1910	1,200	14	60	38	Irr.
Nicatous Lake, Me.	.....	5,574	14	.....	8.17	.....
Santa Maria, Col.	1912	636	14	85	71	Irr.
Rio Grande, Col.	1913	.....	14	.....	.....	Irr.
Grand L & Second L., Me.	.....	4,243	14	.....	10.6	.....
Damariscotta L., Me.	.....	4,345	14	.....	10.3	.....
Bear Valley, Cal.	1884	.....	14	49	.....	Irr.
Lower Otay, Cal.	1896	869	14	120	48	W S
Rice Storage, Wis.	1911	4,384	13	.....	10	.....
Owasco Lake, N. Y.	1850	6,657	13	.....	6	.....
Tomhannock, N. Y.	.....	.....	12	.....	.....	W S
Cold Stream Pond, Me.	.....	4,723	12	.....	8.1	.....
Johnstown, Penna.	1911	900	12	80	42	W S
Bumping Lake, Wash.	.....	.....	11	.....	.....	Irr.
Sherburne, Mont.	.....	.....	11	.....	.....	Irr.
Mathias, Ga.	1914	834	10	.....	41	.....
Allagash Lake, Me.	.....	4,864	10	.....	6.65	.....
Eagle & Churchill Lakes, Me.	.....	11,136	10	.....	2.9	.....
Caucomgomoc L., Me.	.....	4,480	10	.....	6.95	.....
Seboeis Lake, Me.	.....	4,090	10	.....	7.6	.....
Carmel, N. Y.	1895	998	10	55	31	W S
Cross River, N. Y.	1908	850	10	106	36	W S
Milton, Ohio	1913	1,700	10	.....	19	.....
Mattawamkeag L., Me.	1862	3,853	10	.....	7.78	.....
Nepaug, Conn.	1916	851	9.560	97	33	W S
Licking, O.	183o	2,700	9.150	.....	11	Nav.
Schoodic Lake, Me.	.....	6,989	9.000	.....	3.97	.....
China Lake, Me.	.....	3,853	8.760	.....	7.04	.....
Gardner Lake, Me.	.....	5,376	8.720	.....	5.00	.....
Nelson, Mont.	.....	.....	8.700	.....	.....	Irr.
Grass Valley, Utah.	1911	975	8.700	.....	29	.....
Long Lake, Me.	.....	2,816	8.680	.....	9.5	.....
Boonton, N. J.	1904	900	8.600	100	25	W S
Kennebago Lake, Me.	.....	1,754	8.360	.....	14.8	.....
Rocky Ford, Utah.	1914	1,129	8.340	.....	24	.....
1st Kokadjo L., M.	.....	3,053	8.170	.....	8.2	.....
St. Froid Lake, Me.	.....	3,328	8.020	.....	7.43	.....
Decatur Dam, Ill.	1920	3,500	8.000	.....	7.04	W S
Rangeley Lake, Me.	.....	6,246	7.900	.....	3.9	.....
Sudbury, Mass.	1896	1,220	7.900	.....	21	W S
Moose Lake, Me.	.....	3,520	7.830	.....	6.9	.....
Harvey Lake, Pa.	.....	659	7.733	.....	38	.....
Amawalk, N. Y.	1897	600	7.680	.....	20	W S
Rest Lake, Wis.	.....	4,000	7.584	.....	6	.....
2nd Conn. Lake, N. H.	1916	2,160	7.500	.....	11	Pow.
San Fernando, Cal.	1914	410	7.500	.....	56	W S
Las Vegas, N. M.	1917	1,100	7.500	70	21	.....
Lake Cleahm, Wash.	.....	.....	7.400	.....	.....	Irr.
Titicus, N. Y.	1894	707	7.167	105	31	W S
Thompson Lake, Me.	.....	4,365	7.110	.....	5.05	.....
Junior Lake, Me.	.....	3,635	7.100	.....	6.05	.....
Telos & Telosinis Lakes, Me.	.....	2,752	7.100	.....	7.95	.....
Long & Mud Lakes, Me.	.....	9,344	7.100	.....	2.33	.....
Cobbosseecontee L., Me.	.....	5,440	7.090	.....	4.0	.....
Stillwater, N. Y.	1903	2,750	6.750	.....	8	.....
Sebasticook Lake, Me.	.....	4,160	6.780	.....	5.0	.....
Great East Pond, Me.	.....	1,690	6.700	.....	12.2	.....
Messalonskee L., Me.	.....	3,424	6.700	.....	6.9	.....
Cathance Lake, Me.	.....	3,437	6.700	.....	6.0	.....
Otis, Mass.	1885	1,065	6.600	.....	20	Pow.
Eagle Gap, O.	1915	1,518	6.540	.....	14	.....
Tumalo, Ore.	1914	1,100	6.540	.....	19	.....
Spencer Lake, Me.	.....	1,150	6.500	.....	13.3	.....
San Andreas, Cal.	1874	549	6.500	90	36	W S
Ossipec Lake, Me.	.....	3,885	6.450	.....	5.1	.....
Ross Lake, Me.	.....	3,776	6.430	.....	5.27	.....
Little Sebago L., Me.	.....	1,882	6.400	.....	10.4	.....
Cross Lake, Me.	.....	3,136	6.130	.....	6.05	.....
Pueblo, Col.	1908	818	6.000	30	22	W S
Sweetwater, Cal.	1887	722	5.882	70	25	Irr.
Fulton Chain, N. Y.	1881	3,835	5.850	.....	5	.....
Great Tunk Pond, Me.	.....	1,594	5.700	.....	10.4	.....
Sabattus Pond, Me.	.....	2,918	5.700	.....	6.0	.....
Willow Creek, Mont.	.....	.....	5.400	.....	.....	Irr.
Moose Pond, Me.	.....	1,664	5.310	.....	9.85	.....
Moxie Lake, Me.	.....	1,734	5.270	.....	9.4	.....
Laramie, O.	1884	2,000	5.230	.....	8	Nav.
Portage Lake, Me.	.....	3,968	5.160	.....	4.0	.....
Crawford Lake, Me.	.....	1,715	5.010	.....	9.0	.....
Lake, Me.	.....	2,182	4.980	.....	7.05	.....
Castilla Ck., N. M.	1917	.....	4.890	90	.....	.....
Sodom, N. Y.	1890	575	4.883	72	26	W S
Minocqua, Wis.	1890	7,238	4.880	.....	2	.....
Donnells Pond, Me.	.....	1,299	4.730	.....	11.2	.....
Long Pond, Me.	.....	2,982	4.670	.....	4.8	.....
Pierce Pond, Me.	.....	1,568	4.640	.....	9.1	.....
Langon Deerskin, Wis.	.....	6,982	4.570	.....	2	.....
Hemlock, Conn.	1913	500	4.500	80	28	W S
View Desert, Wis.	1870	4,781	4.500	.....	3	.....
Musgugcook Lakes, Me.	.....	2,816	4.490	.....	4.9	.....
Auburn Lake, Me.	.....	2,221	4.340	.....	6.0	.....
San Leandro, Cal.	1875	335	4.323	100	40	W S
Conconcully, Ore.	1909	460	4.230	60	28	Irr.
Calaveras, Cal.	1918	.....	4.200	.....	.....	W S
E. Canon Cr., Utah.	1903	280	4.160	100	46	Irr.
Bog Brook, N. Y.	1890	410	4.145	54	31	W S
Goose Pond, N. H.	1919	655	4.040	.....	20	Pow.
Middle Branch, N. Y.	1878	432	4.000	.....	54	W S
Green Lake, Me.	.....	2,835	4.000	.....	4.35	.....
Duck Pond	.....	1,434	3.990	.....	8.6	.....

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Balcony Beam Splice Questioned

Sir—Quite a lot of discussion developed a few months ago over the detail shown in the sketch attached, representing balcony beams in a high school. The question was the value of the splice in bending, and also its safety in a public building. The writer designed, under protest, the splice as represented, except that he used more rivets in the web plates, which was changed by the chief draftsman. The beams were fabricated and erected as per detail shown



BEAM SPLICES WITH BENT COVER PLATES USED IN A HIGH-SCHOOL BUILDING

and are apparently standing the test, but the writer nevertheless doubts the wisdom of such practice. It seems to the writer that the construction, of which three cases are shown, involves possible arch action (Case 1) or suspension action (Case 3), as well as a tendency of the bent cover plates to straighten out (lower plate in Case 1). The writer would like to see further discussion of the design. No doubt full-size tests would be of great value.

Richmond, April, 24. R. W. BOWMAN.

For Better Engineering in Buildings

Sir—The writer wishes to second the views expressed by John A. Ferguson in your issue of April 20, p. 665. The Association of General Contractors and the American Association of Engineers are to be congratulated on their initiative and results in investigating and reporting on the collapse of the Knickerbocker Theater. Every serious collapse should be investigated in a similar manner, for the benefit of the engineering profession and incidently the public at large. Unless this is done, too little attention may be given to such important matters. Usually individual investigations and reports are made in behalf of those vitally concerned by one or more experts, whose reports are used entirely for the benefit of the client and consequently may or may not be given publicity. Indictments are expected to follow disasters of this kind and each client is naturally concerned in his own interests. The expert therefore submits a report to his client's attorneys and governs himself accordingly. It may thus happen, as it frequently does, that the real cause of the disaster is never made public, if indeed it is found at all.

A very important lesson to be emphasized is that the engineer of a structure is held to be directly responsible for its safety. This being established, it should be given wide publicity to architects and owners, for the purpose of impressing upon them the fact that this responsibility can only be safely entrusted to competent and experienced men, whose compensation therefore must be made entirely adequate.

It behooves owners and architects to select an engineer as carefully as they would an attorney, by his specific qualifications for the work to be done, and expect to compensate him in a similar manner. High-grade attorneys handling responsible work are well paid for their services and so should engineers, doing equally responsible work, be well paid. The writer mentions this because frequently the client engages less expensive services because he does not fully realize the importance and value of the services required.

The general public, including owners and a certain class of architects does not seem to realize the true value of engineering services. On this account it frequently happens that inexperienced and inexpensive engineers are engaged to do work which they are not able to do. Too much stress cannot be laid on this point. Engineers in general owe it to themselves as well as to the engineering profession to undertake to enlighten clients in particular and the public in general on this subject. This is one of the most important features in engineering practice and is one of the features which has been greatly neglected.

In order to improve the standing of engineers with the public at large it is necessary that all possible publicity be given to them and their work. It would seem to be both proper and ethical to do this if it is carried through in the right direction. Engineers have a tendency to give their work publicity within professional circles, not outside of the profession. Such publicity would be beneficial not only to the engineer but also to those to whom the publicity is given. It would be for their protection and their benefit that the engineer would be striving.

That the foundation of building construction is engineering was demonstrated by recent collapses. If a structure is made structurally sound there can be no failure. It must be made not only structurally sound but economically sound as well. Consequently every effort should be made to impress upon those requiring engineering services that they should employ only those who are thoroughly competent to undertake the work and that they must expect to pay for these services at a rate commensurate with the importance of the work to be done.

H. ROBINS BURROUGHS.

New York, April 25.

Detail of Scissors Roof Truss

Sir—Two recent fatal building failures caused by faulty details lead me to comment on the scissors roof truss of which you published a description in your issue of Feb. 23, p. 309. The detail in the joint of the bottom members at the middle is faulty, in the writer's opinion, as eccentricity will increase the stress in the material beyond a safe point.

If good appearance is the prime consideration, make the most of it; halve the timbers and fit the central crotches with knees, preferably natural-growth knees, properly let into the beams. No bolts would be required, as the truss rods will perform their function, but if desired a few spikes, lagscrews, treenails, or the like might be used. Cast side plates may also be used.

A construction all of wood will look better, I believe, and will also be preferable from the constructional standpoint. Not over 25 per cent of the gross area of the timber will be lost. J. M. S.

Brooklyn, Feb. 27.

[The author of the original article on the scissors truss with special joint replies as follows.]

Sir—I should have covered the matter of eccentricity in my original description of the truss detail. The eccentricity amounts to 2.7 in., and the total stress is 24,000 lb., making a bending moment of about 69,000 in.-lb. The upper end of the member is held against lateral movement, however, which prevents bending of the back of the hook. The lateral force against the end of the stick required for this action is 69,000 ÷ 78 in., or 900 lb. The top chord alone is not capable of carrying this lateral force, but the roof planking will transmit it to the end support and to the peak, where it is neutralized by an equal and opposite force from the other rafter. If one wished to be very precise, and could be sure of proper inspection, he might call for the

trusses half one hand and half opposite hand, in which case the 900-lb. thrust would be taken care of even more directly.

As to detailing the joint with knees, it seems to me as if the upper knee would have to do most of the work of transmitting the tension in one member to side bearing on the other, and that most of the tension would be bound to go through the halved joint. This joint is reduced in bearing by the hole for the vertical rod to, say, 7¾ x 2¼ in., or less than in my design. DAVID C. COYLE.

New York, March 31.

Map Scales and the Metric System

Sir—In your issue of April 6, 1922, the question is put up to the readers: Shall map scales be decimal, or inch-to-the-mile? The writer agrees with Mr. Bonner that there is hardly any excuse for using much longer the present scale of 1:62,500. The adoption of this scale was most probably a rather unfortunate compromise between the decimal and the inch-to-the-mile scale. However, as a decimal scale it cannot very well be made use of to great advantage because the proportion of 1:62,500 is very cumbersome for calculations, and as inch-to-the-mile scale the unit length on the map differs from one inch just enough to prohibit the use of the inch scale for most purposes. On the other hand, the difference is so slight that this is a constant source of error and misinterpretation.

The fundamental requirement for a map scale which is best suitable for general purposes is such a scale which permits taking off distances directly with such *measuring scales as are used in everyday life.* At the present time, therefore, it would appear that the inch-to-the-mile scale and its multiples were the logical ones to use.

However, in the United States as well as in England, recent tendencies favor strongly the general introduction of the metric system. In fact, the requirements of international trade will sooner or later force all countries with considerable export trade to adopt the decimal system wherever competition is keen enough to make a difference of a few percent the margin between success and failure.

Whoever has had occasion to compare the relative efficiencies in calculation with dollars and cents in the United States and pounds, shillings and pence in England will fully appreciate the enormous advantage of the decimal system. About the same relation in efficiency exists when calculating with metric units of measures and weights as compared to the so-called English units. These conditions are accentuated by the growing general use of calculating machines and other devices, which all tend to increase the relative efficiency of the decimal system.

The United States and England will therefore hardly be able to escape much longer the necessity of adopting the metric system, whatever the cost and the inconvenience during the period of transformation from the old to the new system may be. For this reason the writer would suggest caution in spending money and time now for a change in the present map scales, however desirable a change to the inch-to-the-mile scale may appear to be. The adoption of the metric system in the United States is bound to come, and the experience of the war and after-war period no doubt has increased the desire for early action in this matter.

There is another reason which argues against the change of the 1:62,500 scale to the inch-to-the-mile scale. The difference between the two scales is so small that, unless particular attention is being paid when working alternately on maps of either scale, a constant source of error and most annoying misinterpretations would be created. By adopting either immediately or in the near future the metric system of 1:50,000, 1:100,000, etc., the chances of error are greatly diminished, and the maps would be drawn to a scale admirably suitable after the general introduction of the metric system, which is bound to come some day.

FRED A. NOETZLI,
San Francisco. Chief Engineer,
April 25. Beckman & Linden Engineering Corp.

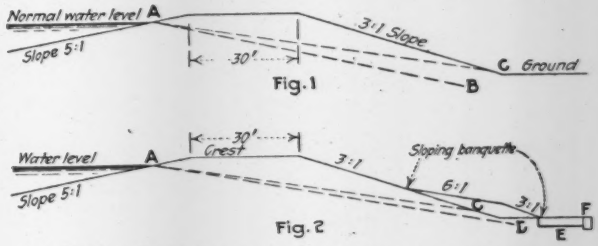
Sir—I have noted with interest the article on map scales. A number of the new maps compiled, engraved and published by the United States Geological Survey using the scale 1:1,000,000 are now available. It is obvious that 1 mm. on these maps represents 1 km. in actual distance. The convenience of this hardly needs comment. Then, too, this is practically identical with the scale 1 inch to 16 miles, which relationship will be of use until the metric system has come into general use. On these maps heights and depths are noted in meters. This scale has been adopted by the United States, Great Britain and practically all other nations for the new maps of the world. HOWARD RICHARDS,

New York. Secretary American Metric Association.
April 18.

Behavior of Low Earth Dam

Sir—In connection with George C. Love's letter in your issue of April 6, p. 579, on the behavior of a low earth dam, it would be interesting to know in what relation the present water surface stands to the lines between the old and new work after raising the dam "twice by adding material to the crest and lower slope."

The crest and slopes shown are certainly ample and the resulting sections generous, but the dam's behavior is disconcerting. I would suggest that the water found its way along the junction between the old and new work, first along the level top of the older portion and then down the old



EARTH DAM SATURATION, SLIDING AND REPAIRS
Reproduced from *Engineering News-Record*, April 6, 1922, p. 580.

slope, making the line of saturation to appear as a reverse curve and finally causing movement of the added fill on the downstream face.

In a homogeneous material the line of saturation drops sharply at the upper end, due to surface resistance to entrance, and is further modified by the selected material in the center of the dam.

The ditch and laterals at the toe of the dam were good medicine and effective in spite of the clay "banquette." The latter should have been rock or gravel or else omitted. Should the drains become clogged, the clay will hold the water in the toe until it rises above and is forced out over the clay, still further saturating the structure.

Many earth dams have been built in the West and in recent years a number of high earth dams have been built in the East and others are in process of construction. The design and execution of some of these structures has been given careful study, as described in Trans. Am. Soc. C. E., Vol. LXXXIII, p. 1713, Vol. LXXXIV, p. 331 and in the Proceedings for March, 1922, p. 453. J. ALBERT HOLMES.

Decatur, Ill.

War Material for Highways Totals $126,000,000

Up to Feb. 1, 1922, the value of surplus war material distributed to the states for highway work by the U. S. Bureau of Public Roads amounted to $126,000,000, of which $90,000,000 represented the value of motor vehicles and parts. Recently an inventory was taken of about $40,000,000 worth of material at Camp Grant, Rockford, Ill., part of which will be retained by the War Department and all of the remainder suitable for road work will soon be available for distribution. The work is being rushed so that the material may be used for road work early in the season.

NEWS OF THE WEEK

New York, May 11, 1922

Defense Wins Strong Point in Cement Trial

Second Count of Indictment Charging Specific Contract to Restrain Trade Is Dismissed

Hearing of the motion made by the defense that the indictment, under which cement manufacturers of the Eastern district are being tried before a federal jury and Judge Knox in New York City, be quashed resulted in the dismissal, May 8, of the second of the two counts on which the defendants are being tried. After two days of argument Judge Knox sustained the contention of the defense that the second count, charging a specific making of a contract to engage in interstate trade in violation of the Sherman law, should be dismissed because it was barred by the statute of limitations. The court, however, found that enough evidence had been adduced by the prosecution to allow the case to proceed on the first count of the indictment which charges, generally, that the defendants unlawfully engaged in a combination to restrain trade by restricting competition.

The facts surrounding the dismissal of the second count were essentially as follows:

The government charged that when the Cement Manufacturers Protective Association was formed the defendants adopted "the Eddy plan of open competition" by the operation of which all the defendants subscribing thereto automatically entered into a contract to restrain interstate commerce by restricting competition, fixing prices, etc. However, the Cement Manufacturers Protective Association was formed Jan. 2, 1916, whereas the indictment against the defendants was not returned until August of 1921.

CONTENTION OF GOVERNMENT

It was the government's contention that the formation of the association, the entering into it of the defendants and the active participation in its proceedings by the defendants constituted a continuing contract and that inasmuch as all of the defendants had either attended or had otherwise exhibited interest in meetings within the three-year period before which the statute of limitations operates, they were all liable. The defense held that the actual entering into by the defendants of the alleged contract for trade restraint (the formation of the Cement Manufacturers Protective Association) happened more than three years before the indictment was returned and was therefore barred by the statute of limitations. The defense cited one U. S. Supreme Court case in which a distinction had been made between the signing of a specific contract and the continuance of a combination. It was upon this case that Judge Knox instructed the jury to return a not guilty verdict on the second count.

(*Continued on p. 806*)

Hoover and Roosevelt To Lead Construction Council

Secretary Hoover has accepted the chairmanship of the formal organization meeting of the American Construction Council to be held in Washington June 19, and Franklin D. Roosevelt of New York, formerly Assistant Secretary of the Navy, has agreed to accept the first presidency of the organization.

These two important matters settled, the committee of secretaries which has the organization details at hand, is proceeding rapidly to secure the adherence of the various organizations in the industry. Formal invitation together with supporting arguments are now going to the 250 national organizations.

The committee, which is acting under the chairmanship of Gen. R. C. Marshall, Jr., reports that responses, thus far, are very encouraging. Commendation of the movement and promises of support are universal.

Wilgus Resigns as Consulting Engineer on Narrows Tunnel

Following the abandonment by the City of New York of the Narrows tunnel project for a trunk-line terminal railroad system and the adoption of a new plan for a local development based on the tunnel (*Engineering News-Record*, April 13, 1922, p. 626), Col. William J. Wilgus has resigned as consulting engineer to the Board of Estimate and Apportionment. It is understood that in carrying out the new project the board contemplates calling from time to time for the advice of specialists in the various problems involved instead of maintaining a staff of consulting engineers on a permanent basis.

Lawsuit to Prevent Bayonne from Building Ramapo Reservoir

A writ of *certiorari* calling for a review of the action of the New Jersey Department of Conservation and Development in granting the city of Bayonne a permit to build a 50-m.g. impounding reservoir on the Ramapo River has been granted by a New Jersey court. The applicant for the writ is a resident of Bayonne and owner of one of a number of large estates that it is alleged would be flooded by the reservoir. Other litigation designed to thwart Bayonne's Ramapo project has been threatened by municipalities and private interests. The granting of the permit was opposed by the North Jersey District Water Supply Commission, which is building a storage dam on the Wanaque River for Newark.

Further Report on Palm Beach Bridge

Outside Investigation of Collapse of Structure on Dec. 29 Now Probable

An investigation by an outside engineer is to be made of the bridge collapse at Palm Beach, Fla., Dec. 29, according to action taken last week by the county commissioners. Several consulting engineers are under consideration for the investigation.

It is understood that the incentive for this step came from representatives of bond holders.

A supplementary report by Harrington, Howard & Ash, designing engineers of the bridge, has been made public in the Palm Beach *Post*. This report, supplementing a preliminary report made shortly after the collapse (see *Engineering News-Record*, Jan. 26, p. 150), states that serious defects of construction were found in the bases of the east abutment and piers 13, 11, 8 and 7. Pier 12 had the forms still in place and therefore could not be examined, while piers 10 and 9 were concealed by sand and debris, making examination impossible, but the engineers express the belief that defects of construction in these pier bases would be found similar to those in the ones reported upon. They report that in every joint between pourings of concrete (the pier concrete was largely placed under water) there exist "large amounts of soft and defective material, laitance and scum, which is not concrete, contains little or no stone and is not capable of supporting loads. In some places this material adjacent to the exposed surfaces has fallen out, washed out or otherwise been displaced, leaving holes extending well into the bases and varying in width from an inch or so to a foot."

SPECIFICATIONS

The work was done under specifications which provided that the concrete of the pier bases might be deposited in open cofferdams or cribs after pumping out, or might be deposited entirely under water; actually the concrete was placed under water in two to five pourings for each pier base. It was specified that before one pouring of concrete is placed on another, scum and laitance should be removed from the surface, but the engineers report that this requirement was ignored. Some of the upper concrete, which was required to be placed after pumping out, was also poured in water. The engineers further say, "These operations of the contractor, contrary to the specifications and contrary to the plans, were carried on with the knowledge of our inspector and evidently with only mild objections on his part, although clearly contrary not only to the plans and specifications, but to the special instructions written to him."

(*Continued on p. 806*)

Wheeling Votes $2,000,000 for Water Treatment Plant

After delays extending through many years and much agitation over the various plans for an improved water supply for Wheeling, W. Va., the voters of that city recently approved a $2,000,000 bond issue for building a water-treatment plant. Chester & Fleming, Pittsburgh, are engineers for the improvement. C. H. Dowler is city manager.

St. Louis Committee Passing on $73,000,000 Bond Proposal

City bond issues totalling $73,000,000 are being considered by a special committee of 200 members chosen to pass on the advisability of submitting them to popular vote at an election to be held in the fall. The total includes $12,000,000 for water-works recommended by Edward E. Wall, water commissioner of St. Louis (see *Engineering News-Record*, March 16, p. 437).

San Francisco Awards Contracts on Hetch Hetchy Power Units

The San Francisco Board of Public Works on April 28 awarded contracts for equipment to be used in the Moccasin Creek power plant on the Hetch Hetchy water-supply project. It is the present intention to sell power from this plant to one of the large power companies. Deliveries on the units for which contracts have just been awarded are limited by agreement to the period between April 15, 1923, and Aug. 31, 1923.

Contracts awarded were as follows: Pelton Water Wheel Co., four 25,000-hp. double-overhung impulse units, $248,000; General Electric Co., four 20,000-kva. generators with exciters and one spare exciter set, $260,285; and the Coffin Valve Co., eight 36-in. valves, $37,586. The electrical units involve a departure from standard practice in that they have direct-connected overhung exciters.

To Announce Plans for Extensions of New York Transit System

Comprehensive plans for rapid transit subway extensions in New York will be announced by the Transit Commission some time this week. Advance information indicates that the complete program will involve the expenditure of $250,000,000 and will include the following items:

1. A 4-track subway the length of Manhattan Island following the line of Eighth and Amsterdam Aves. 2. Extension of Seventh Ave. subway up Central Park West and Eighth Ave. to the Harlem River. 3. Brooklyn cross-town line running from Queensboro Bridge Plaza to connect with existing lines in central Brooklyn. 4. Extension of the Fourth Ave. subway in Brooklyn under the narrows to Staten Island. 5. Extension of the Queens-Corona line from Corona to Flushing. 6. Moving platform on 42nd St. to replace existing shuttle service between east-side and west-side subways.

Construction of any of these lines will be subject to approval and appropriation of funds by the Board of Estimate and Apportionment of New York City.

The Engineer in Public Life

While engineers, as a class, have been charged with neglect of public responsibilities, individual members of the profession have engaged in public service of a non-engineering character. "Engineering News-Record" desires to record their activities in a series of biographical sketches, of which this is the first. Readers can aid in making the series complete by sending to the editor the names of any engineers who should be included.—EDITOR.

CHARLES SAVILLE

For nearly two years an engineer has been serving as the executive head of the Chamber of Commerce of Dallas, Texas. Starting his association with that organization in 1918 as secretary, Charles Saville, a specialist in the field of municipal and sanitary engineering since his graduation from the Massachusetts Institute of Technology in 1905, became its general manager in September, 1920. Mr. Saville was born in Brookline, Mass., in 1883, and after completing his university training and spending ten months herding sheep in Montana, he served for six years as sanitary engineer and special investigator for the Massachusetts State Department of Health.

After a European trip of fifteen months beginning in 1910, devoted to a study of foreign sanitary engineering practice, he went to New York in 1911 and became a member of the firm of Hering & Gregory, hydraulic and sanitary engineers. He moved to Dallas, Texas, in 1914, opened a consulting office and the following year was appointed director of sanitation and public health of Dallas. As secretary of the Committee on Sanitation of the Texas State Council of Defense during the war he organized and directed public health activities throughout the state, having charge of 110 community councils in school districts of Dallas County. He served also as consulting engineer and sanitarian for the U. S. Army on sewage disposal and malaria control in camps at Fort Worth and at Dallas and at shipbuilding yards at Orange. Due largely to his efforts as executive secretary the drive for the fourth Liberty Loan in Dallas reached its quota of $10,250,000 in three days.

After service as vice-chairman of the Texas Public Health Commission, appointed by Governor Hobby as a war measure, Mr. Saville became in October, 1918, director of industrial development and later secretary of the Dallas Chamber of Commerce. Here his activities included such matters as city planning, housing, open shop agreements, tuberculosis prevention, the Boy Scouts of America and the Dallas charities. He assisted also in organizing chambers of commerce in several other Texas cities.

Will Not Buy Out Superior Water, Light & Power Co. Now

At a recent popular election the voters of Superior, Wis., rejected the offer of the Superior Water, Light & Power Co., to sell its property to the city for $3,115,000 plus certain additional allowances. Condemnation proceedings were started by the city several years ago. A few months ago the company offered to sell out on the terms stated above. W. C. Lounsbury, general manager of the company, informs *Engineering News-Record* that "the whole question is involved and this action by the voters may or may not mean that the agitation for municipal ownership is over."

Trips to Water and Sewage Works for Civil Engineers

In connection with the annual convention of the American Society of Civil Engineers to be held at Portsmouth, N. H., June 21-22, trips of inspection to New England water-works and sewage-treatment plants are being arranged by Harrison P. Eddy, of Metcalf & Eddy, consulting engineers, Boston. These trips will be by automobile and are planned to take place prior to the convention on June 19 and 20 without interfering with the convention program. Members of the society are requested to inform Mr. Eddy of their desire to visit any or all of the following works: Sewage-treatment plants at Worcester, Marlborough, Clinton, Fitchburg and Boston, and water works at Boston, Cambridge and Lowell.

New Jersey To Study Trans-Hudson Passenger Situation

An unpaid commission of seven members to report on a comprehensive plan of "rapid passenger transit between the several communities in the counties of Bergen, Essex, Hudson, Middlesex, Morris, Passaic and Union, as well as between such communities and the City of New York," has been appointed by the Governor of New Jersey in accordance with an act of the 1922 legislature of that state. The commission has selected as chairman Bertram H. Saunders, who is also chairman of the Paterson City Plan Commission, and as secretary Herbert S. Swan of Glen Ridge, a city planning consultant with offices at 15 Park Row, New York City.

The creation of this commission is the outcome of the Bi-State Rapid Transit Conference held at Paterson on Dec. 15 (*Engineering News-Record*, Dec. 22, 1921, p. 1037) which led to the formation of the North Jersey Rapid Transit Committee, with Mr. Saunders as chairman and Mr. Swan as secretary. This committee drafted the act already mentioned—which was passed unanimously by both houses of the legislature.

The act authorizes the commission to "employ such professional skill and assistance as it may need for the effective working out of a comprehensive and adequate plan of rapid transit." The commissioners themselves are to serve without compensation. The act carries an appropriation of $5,000 to be paid out "of any moneys in the state treasury not otherwise appropriated."

Illinois River Flood Highest on Record

Gage Readings Show Stages as Much as 5 ft. Higher Than Ever Before Known

Probably the biggest flood ever experienced on the Illinois River during modern times was that of April, 1922, which exceeded all previous flood heights. Numerous cities and great areas of agricultural lands were flooded.

In the accompanying table are shown the gage readings at several points, all exceeding those of any previous year in which readings were actually recorded. It will be noted that at Beardstown, the stage was 5.1 ft. higher than in 1904, while at Havana the excess was only 2.7 ft. This condition was caused by heavy and long continued rains on the drainage area of the Sangamon River. The tabulation was made by the Elliott & Harman Engineering Co., Peoria, Ill.

Profiles of the rise and fall of the flood at several points are given in the accompanying diagram furnished by M. G. Barnes, chief engineer of the State Waterway Division and based on the figures of the U. S. Geological Survey. A profile of the 1916 flood was given in *Engineering News*, March 23, 1916, p. 550.

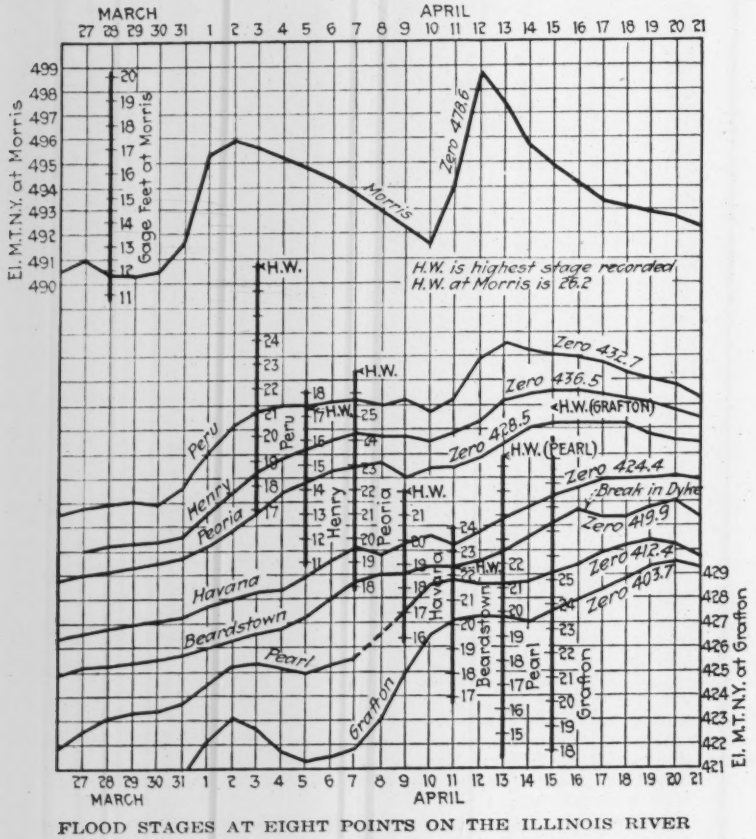
Strenuous work was done in endeavoring to save the levees of the twenty-eight drainage districts along the river. But breaks occurred causing the flooding of twelve districts aggregating 72,800 acres, the estimated damage being $2,870,000. At the other districts the levees held, protecting 112,500 acres, but flood damages in these districts are estimated at $209,000. These figures are based on estimated losses of all crops for this season in the flooded districts. The Pekin-LaMarsh district of 3,500 acres was protected at the north by two railway embankments 400-ft. apart, but the outer and older one gave way as a result of seepage and the rush of water carried away the other bank.

FLOOD DATA AT STATIONS ABOVE AND BELOW PEORIA, ILL., 1922 AND 1904

Station	Crest* Ft.	1922 Date April	Condition on April 26 Ft.	1904 Crest Elev.** Ft.	"O" State Memphis Data Ft.
Peru	23.8	13	19		443.79
Henry	18.0	15 & 16	14.9	17.2	435.82
Peoria	24.8	15	22.6	23.0	431.67
Havana	22.6	20	21.7	19.9	427.25
Beardstown	25.1	20	24.1	20.0	419.70
Pearl	22.8	20	21.4	(1903-20.7)	

* These readings were on scratch tabulations, and there may have been slight variations between readings not shown in this report. Readings at Pearl were not secured on April 18 and 19. The crests at Havana, Beardstown and Pearl were affected by the breaking of levees along the river near those points.

** The 1919 and 1920 floods were slightly higher than 1904 flood in most places.



FLOOD STAGES AT EIGHT POINTS ON THE ILLINOIS RIVER

State Sanitary Engineers Will Meet in Washington, D. C.

The third annual conference of state sanitary engineers will be held in Washington, D. C., at the Department of the Interior Building on May 17 and 18, concurrently with the annual conference of state and territorial health authorities with the United States Public Health Service. The program is made up largely of committee reports on water supply and water purification, control and limitation of chlorination, milk supply, sewage and stream pollution. Remarks of Imhoff tank patents are to be made by William F. Keohan, Washington representative of the Chemical Foundation. Clarence Marsh, New York City, is to speak on the electrolytic production of chlorine, and E. S. Tisdale, Charleston, W. Va., will talk on educational campaigns for better water supplies.

City Planning Conference to Be Held at Springfield, Mass.

The fourteenth National Conference on City Planning is to be held at Springfield, Mass., June 5-7, in conjunction with the annual convention of the Massachusetts Federation of Planning Boards. Among the subjects to be presented are "The Treatment of the River Front," one of the speakers on which will be Edward H. Bennett of Chicago; "City Planning in Relation to Transportation and Street Traffic," E. P. Goodrich of the Technical Advisory Corporation, New York City, and D. L. Turner, chief engineer, New York Transit Commission, and "Methods of Winning Public Support for a City Planning Program," S. C. Kingsley, director, Welfare Federation of Philadelphia and Dr. Samuel B. Woodward, chairman, City Plan Committee, Worcester.

Railroad Gets Time Extension on Branch-Line Construction

The Salt Lake & Denver R.R. has been granted an extension of two years in which to start construction of a line into the Uinta Basin, Utah. An order to this effect has just been made public by the Utah Public Utilities Commission. Objection to this extension was made by the commercial clubs of Vernal and Myton, Utah, but the commission, believing this to be the only hope this territory has of getting railroad facilities in the near future, and recognizing the efforts and time spent by the railroad to promote this particular line, have extended the time for starting construction to Feb. 25, 1924.

Rescind Bids for $3,000,000 Public Improvements in Florida

The Hillsborough County Commissioners at Tampa (Fla.) rescinded the proposed opening of bids April 24 on seventeen road projects, a bridge, a seawall and a fill all to total $3,000,000. Included in the work was the proposed Bayshore drive from Tampa to Ballast Point, similar to the Havana Malecon.

It is now proposed first to vote and sell the bonds and then readvertise, though the exact procedure is still indefinite. The bids had been requested "subject to the subsequent voting and sale of the bonds."

Give Transportation Act a Fair Trial, Say Railroad Men

From many angles the railroad problem was discussed authoritatively at an all-day meeting of the Academy of Political Science held in New York April 28. The opinion prevailed that the Transportation Act of 1920, including the establishment of the Railroad Labor Board, has not yet had a fair chance to prove its worth and that it should not be fundamentally changed at the present time.

At the luncheon session attended by nearly 600, Henry C Wallace, Secretary of Agriculture, declared that unless freight rates come down the country will be confronted by profound readjustments in its agricultural and industrial activities. Daniel Willard, president of the Baltimore and Ohio R.R., urged a five-year trial of the Transportation Act in its present form. He favored that portion of the act which provides that the government shall take over one-half of net operating income above 6 per cent and questioned the wisdom of any legislation to prohibit strikes by railroad employees. Walker D. Hines, former Director General of Railroads, endorsed Mr. Willard's plea on behalf of the Transportation Act.

At the morning session Prof. Frank H. Dixon, of Princeton University, explained the functions and policies of the Railroad Labor Board and W. N. Doak, vice-president of the Brotherhood of Railroad Trainmen, discussed them from the viewpoint of the employee. C. B. Heiserman, general counsel, Pennsylvania R.R., and Henry T. Hunt, former member of the board, discussed them from the railroad and public angles with special reference to the current controversy between the Pennsylvania R.R. and the shop crafts. At the afternoon session Charles R. Hook, vice-president and general manager of the American Rolling Mill Co., explained the effect of freight rates on the cost of steel making, and J. D. A. Morrow, vice-president of the National Coal Association, showed how much of the retail price of coal goes to pay for transportation. Prof. Wm. J. Cunningham, of Harvard University, indicated what the railroads might do to render maximum service while R. H. Aishton, president of the American Railway Association, told what they are now doing to increase economy and efficiency.

Samuel McCune Lindsay, president of the board of trustees of the Academy, presided at the luncheon session. Prof. Henry R. Seager of Columbia University at the morning session, and Albert Shaw, editor of the *Review of Reviews*, at the afternoon session. Information as to the published proceedings and future meetings of the Academy may be obtained from the Secretary, Academy of Political Science, Kent Hall, Columbia University, New York City.

French Line Starts To Electrify

A large program for electrification of about 2,000 miles of line on the Paris & Orleans Ry. is to be commenced this year by the construction of three power plants and the line equipment of the Paris-Vierzon division. Orders for 200 electric locomotives have been divided between three French firms. At 1914 prices the cost for the 2,000 miles was estimated at $94,000,000.

Municipal Improvements Convention Date Changed

The convention committee has changed the date of the 1922 convention of the American Society for Municipal Improvements to Oct. 1-6, 1922. It is to be held in Cleveland.

New Ohio River Bridge Built in 274 Days

Dedication of the new Ohio River highway bridge at Ironton, Ohio, connecting with Russell, Ky., marked the completion of construction in 274 days. Work on the foundations was begun by the Dravo Contracting Co. last July, and erection of the superstructure steel was begun in the fall by the Wisconsin Bridge & Iron Works, designers of and contractors for the bridge. The bridge has a main span of 725 ft., this being the central span of a cantilever structure 1,425 ft. long between anchor piers. (See "Engineering News-Record," Oct. 13, 1921, p. 613, for span diagram.)

The governors of Ohio, West Virginia and Kentucky, as well as United States senators and a large number of railway officials attended the dedication, which centered about the state line, here located along the low-water line on the north side of the river, as fixed at the time when the Northwest Territory was set off from Virginia.

The cost of the bridge was about $700,000. Money was raised locally, and 2,424 persons hold stock in the company. The bridge will be operated on a toll basis.

Reclamation Act Amended

The Senate on April 2 passed a bill already approved by the House amending the U. S. Reclamation Service Act so as to permit the federal and the state governments to take bonds of irrigation districts as a substitute for the securities of the individual entrymen heretofore required. The Senate amendment permits federal land banks to make loans on irrigation projects. This, if agreed to by the House, will remove the inhibition of the Farm Loan Act against loans secured by irrigation projects.

Court of Appeals Decision on Flat-Slab Patent

Justice Alschuler sitting with Justices Baker and Evans, United States Circuit Court of Appeals for the Seventh District, in January affirmed the decision of the District Court for the Northern District of Illinois, Eastern Division, that U. S. patent No. 1,005,756 on reinforced-concrete flat slab held by F. F. Sinks, was invalid in so far as it related to claims 2, 4, 6, and 7. This was in the case of the Condron Co. against the Corrugated Bar Co., and means in effect that the upper court has held that the so-called Akme system is not patentable. The lower court decision was noted in *Engineering News-Record*, issue of May 1, 1919, p. 889.

Urge Three-Year Federal-Aid Road Program

Effort Will Be Made in Senate to Secure Yearly Appropriation of $75,000,000

(Washington Correspondence)

An effort will be made in the Senate to provide for a three-year road building program rather than the two-year program prescribed in the bill which just has come to the upper chamber after having passed the House. Thirty-four of the state legislatures meet next January and will not meet again until January, 1925. It is held to be essential in the prevention of economic loss in organization and in securing maximum efficiency that the legislatures know just what the federal government will contribute during a three-year period. Since the states during the past three years have put under contract an average of $82,000,000 federal funds per year, there is very strong sentiment in favor of amending a bill in the Senate so as to make it provide $75,000,000 per year for three years.

Section 4 of the bill as it passed the House is not satisfactory to the state highway officials and W. C. Markham, their representative in Washington, has submitted the following substitute to the Senate committee:

Sec. 4. That if any State, for a period of one year from the date on which the Secretary of Agriculture approves, or heretofore has approved, a project statement for the construction of any road project, shall have failed to commence actual building construction on such project or if contract for the construction of such project shall not have been entered into, the Secretary of Agriculture shall require such State to submit a project statement, or statements, for one or more other projects to replace such project; and if said State, for a period of 60 days from receipt of notice from the Secretary of Agriculture to submit such other project statement, or statements, shall not have submitted the same, then, and in that event, the Secretary of Agriculture shall immediately cancel such project and reapportion the Federal funds allotted thereto among all the states in the same manner and on the same basis as provided by the Federal Highway Act and all acts amendatory thereof or supplemental thereto.

For $20,000 a Mile

An effort also will be made to convince the Senate committee that the bill passed by the House should be amended so as to continue the $20,000 per mile maximum which may be contributed by the federal government. The House reduced the maximum from $20,000 per mile to $12,500 during the first year and $10,000 per mile thereafter. The state highway officials believe that no abuse is resulting from the $20,000 maximum, with the type of construction left to the judgment of the Secretary of Agriculture. They point out that the average federal aid per mile has been but $7,415.

Representative Begg, of Ohio, made strenuous objection, during the consideration of the bill in the House, to a maximum as high as $20,000 for federal aid. He suggested that a $4,000 maximum would be better. He opposes the whole system of federal aid, however, and declares the states have already surrendered 90 per cent of their police powers so that the highways, the railroads, the education and the health may be nationalized. He presented, somewhat newly garbed, the argument that a few of the states pay most of the taxes and, as a result, are being taxed out of all equity for road construction.

Temporary Sewage Treatment Plant for Los Angeles

The Los Angeles city council on April 24, in accordance with the recommendation of John A. Griffin, city engineer, appropriated $153,000 from the city's reserve fund with which to purchase 33 acres of land on Angeles Mesa and to build there, pending the construction of some means of permanent disposal, Imhoff tanks and filters to treat the raw sewage now discharged into Ballona Creek to relieve the ocean-outfall sewer. (See *Engineering News-Record*, Feb. 23, p. 366, March 2, p. 343, April 13, pp. 596 and 618.) The Los Angeles Community Development Association, with the unanimous approval of the city council, has decided to appoint a citizen's committee of fifteen to work independent of other agencies in gathering facts as to the need of increased sewage-disposal facilities and the relative merits and costs of the various methods of disposal which have been suggested. An endeavor is to be made to unify public opinion on a definite workable sewage-disposal program so that there will be whole-hearted support at the time when the voters are asked for the fourth time to vote bonds for additional and improved means of sewage disposal.

Defense Wins Strong Point in Cement Trial

(*Continued from p. 802*)

Judge Knox also instructed the jury to return a verdict in favor of the Allentown Portland Cement Co. of New Jersey, a defunct organization. The indictment named this company through error, the Pennsylvania company by the same name having been the company the indictment should have named. However, the Allentown company of Pennsylvania is still represented in the trial by one of its officers, who is an individual defendant.

Beside the motion to quash the indictment and to dismiss the first count because of lack of evidence and the second because the statute of limitations barred it, the defense sought to have striken from the records certain testimony of government witnesses. It sought to have stricken out all of the testimony of Mary Kavanagh, a former employee of the Atlas Portland Cement Co. However, the court ruled that only a minor part of her testimony be stricken out. The attempt of the defense to relieve certain defendants from the indictment because of their apparent lack of connection with any of the proceedings of the protective association was of no avail.

The government finished its case on Thursday of last week, having introduced exactly 800 exhibits. Testimony and documentary evidence introduced by the government consumed some 4,000 pages of printed record. The government's case occupied in time four weeks and one day.

The defense opened its case on Tuesday morning of this week by the exhibition of moving pictures, accompanied by a lecture, on the manufacture of portland cement. The lecture was given by H. Bruckman, president of the International Cement Co., who was the defense's first witness.

It is probable that the defense case will consume at least three weeks.

A.S.T.M. Program Announced

The American Society for Testing Materials has issued a provisional program for the twenty-fifth annual meeting which will take place at the Chalfonte-Haddon Hall, Atlantic City, N. J., June 26-30. By far the largest number of items ever included on one of its programs are noted, the number running up to eighty. There are to be twelve sessions, two of them in duplicate with simultaneous meetings on subjects which are assumed not to have interest to the same members.

Monday, June 26, is devoted to committee meetings, and the sessions open Tuesday morning. Following is the program: Tuesday morning, non-ferrous metals, metallography and corrosion; afternoon, wrought, cast and malleable iron; evening, presidential address, report of administrative committee, informal dance and smoker. Wednesday morning, steel; afternoon, committee meetings; evening, symposium on impact testing of materials. Thursday morning, fatigue of metals, methods of testing and nomenclature; afternoon, coal, coke, timber and shipping containers; evening, simultaneous sessions on (a) concrete aggregates, road materials and waterproofing; (b) preservative coatings. Friday morning, simultaneous sessions on (a) lime, gypsum, and ceramics; (b) petroleum products, insulating materials, textiles, and rubber; afternoon, recreation period, golf and tennis tournaments; evening, final session on cement and concrete. The secretary of the society is C. L. Warwick, 1315 Spruce St., Philadelphia.

Road Builders Meeting May 15

The annual meeting and election of officers of the American Road Builders Association will take place May 15 at the Automobile Club of America, New York City. The meeting of members of the association is scheduled for 3 p.m. following a meeting at 10 a.m. of the board of directors. At 6:30 p.m. the annual dinner will be held, after which the program provides for a report on the election results, and addresses by the retiring and the new presidents.

Further Report on Palm Beach Bridge

(*Continued from p. 802*)

Two of the arches, it is said in the report, are found considerably out of correct position. The concrete pushed the pier or skewback forms out of shape and out of position, and the arches then were poured apparently to fit the incorrect arches or skewbacks. In turn, the spandrel wall forms were built to fit the arches.

No grounds were found by the engineers for believing that any settlement of the bed rock under the piers had occurred. "The defects of the piers, together with the improper method of placing the spandrel filling would fully account for the accident which occurred. It is possible also that some of the fallen arches may have been constructed in improper positions." The engineers also report that they have verified the design, plans and specifications and found them adequate.

Engineering Societies

Calendar

Annual Meetings

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 9-11.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION, New York City; Annual Meeting, New York City, May 12.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Philadelphia, May 15-19.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Salt Lake City, Utah, June 5-7.

NATIONAL CONFERENCE ON CITY PLANNING, Boston, Mass.; Annual Meeting, Springfield, Mass., June 5-7.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Portsmouth, N. H., June 21-22.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Convention, University of Illinois, June 20-23.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 26-30.

The Milwaukee Chapter, A.A.E., has elected officers as follows: President, Ralph M. Kibbe; vice-president, H. L. Foster; directors, John A. Harrington and J. A. B. Tompkins.

The Jamestown Engineering Society has elected the following officers: President, W. J. Knauer; vice-president, L. L. Graham; secretary, Archie W. Roberts; treasurer, Francis Irvine.

The St. Joseph Valley (Ind.) Chapter, A. A. E. has elected the following officers for the year: President, H C. Weaver; vice-president, J. L. Stevens; secretary-treasurer, E. R. Austin.

Personal Notes

W. N. RYERSON, for several years manager of the Great Northern Power Co. at Duluth, has resigned to become secretary of the Duluth Chamber of Commerce.

E. S. SMITH, superintendent of public works, department of highways, Ohio, has resigned because of ill health. His successor has not yet been appointed.

C. G. TROWBRIDGE, city engineer and superintendent of construction, Decatur, Ga., has resigned to engage in engineering work with the St. Simons Island Investment Co.

P. J. HURTGEN has been appointed city engineer of Kenosha, Wis., succeeding B. C. Brennan, resigned.

C. U. SMITH has been appointed district engineer of the Chicago, Milwaukee & St. Paul Ry., with headquarters at Milwaukee, Wis. He succeeds O. H. Frick, who has been promoted.

W. L. LOZIER, of Rochester, N. Y., has been appointed engineer in charge of public improvements, Seneca Falls, N. Y.

CHARLES MATER, resident engineer on the construction of the Pearl Street bridge, Grand Rapids, Mich., has resigned to accept another position. A. E. WHITLOCK, one of the staff of the Westcott Engineering Co., will succeed him.

C. E. RICE, city engineer, Wooster, Ohio, has resigned, effective May 1.

JAMES A. MORTLAND, bridge engineer for the Florida State Highway Department, has resigned to open a private office in Tallahassee, Fla., as a consulting engineer specializing in bridge design and construction.

JAMES E. SELLERS, assistant engineer of the Verde River Water Project, Phoenix, Ariz., has resigned and has gone to Chicago for special investigation work in connection with a report of the Colorado Flood Control which he is completing for Chicago interests. Before he assumed charge of the design and construction of the Verde River Project he was senior highway engineer with the Arizona State Highway Department.

A. W. GRAHAM, chief engineer of the Missouri State Highway Department, has resigned, effective May 1, and his assistant C. W. Brown is acting in his place until a permanent appointment can be made.

LESLIE H. BALKNAP, deputy state highway commissioner, Lansing, Mich., has resigned and will be succeeded by G. C. Dillman, an engineer in the department of maintenance.

E. A. VAN DEUSEN has resigned his position with the New England Power Co. to become assistant hydraulic and structural engineer with the United Hudson Electric Corp., Poughkeepsie, N. Y. He was at one time engineer with the Southern Power Co., N. C., and later with the Fargo Engineering Co., Jackson, Mich.

MAJOR WILLIAM A. MITCHELL, Corps of Engineers U. S. Army, has been confirmed by the Senate to be professor of civil and military engineering at the United States Military Academy, West Point, N. Y.

H. P. BORDEN, late member of the Board of Engineers of the Quebec Bridge, and former consulting engineer to the Department of Railways and Canals of the Canadian Government, has opened a consulting office in Ottawa. Mr. Borden will specialize in bridges and structures, both steel and concrete, and in reports, inspections, estimates and investigations. Mr. Borden has had wide experience in bridge engineering practice. After graduation from McGill University, he was assistant engineer in the bridge department fo the Canadian Pacific Ry. He then became assistant chief engineer in the structural department of the Montreal works of the American Locomotive Co. Later, he was made structural engineer of the Canadian Pacific Ry. In 1908, he became assistant engineer, Board of Engineers of the Quebec Bridge, being appointed a member of the board early in 1916 upon the death of C. C. Schneider.

BUSINESS NOTES

A. RENNOLDS, formerly with the Equipment Corporation of America, announces the organization of the RENNOLDS EQUIPMENT CO., with offices in the Lumber Exchange Bldg., Chicago. The Rennolds company will handle a complete line of contractors' equipment and will buy slightly-used machinery to rebuild, sell or rent.

The CONTRACTORS TRADING CO., New York, is to take over the sale of the building construction equipment of the LAKEWOOD ENGINEERING CO. only in the New York territory; roughly speaking the eastern half of the State of New York and the northern half of the State of New Jersey. It will not have charge of all the sales territory of the Lakewood company as might have been inferred from the note in the issue of May 4, p. 755.

EQUIPMENT AND MATERIALS

New Concrete Road Tamper

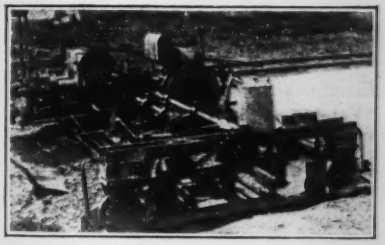
A concrete-road finishing machine which performs several operations simultaneously and finishes the slab by passing over it once has been developed and tried out by the Dunn Road Machinery Co., Conneaut, Ohio. Briefly the machine consists of a carriage which travels on the side forms and carries the power unit and operating mechanism. It is propelled by winding up a cable anchored ahead or to the rear. The operator rides on the machine.

An auxiliary strike-off pushes the surplus material ahead and smooths the slab off about 2-in. high. Behind comes the main strike-off or clearing tamper which has a slow vertical movement to press down the surface stone. Then come in order a spader, a tamper, and a finishing belt. In case reinforcement is used a sub-strike-off is attached ahead of the auxiliary strike-off. The clearing tamper, spader and finishing tamper have special purposes and action as follows:

The clearing tamper has a vertical movement, with a long stroke and runs at a comparatively slow speed, a ratio of 1:3 with the other tamping members. Its action is such that all large pieces of aggregate are pressed down a little below the finished surface, as its stroke is adjustable, but without variation when set; the distance below the surface that it will drive the large pieces can be predetermined. The result of this action is such that the concrete is pressed or squeezed into a dense mass, but without separating the coarse from the fine material.

The spader is a blade $\frac{3}{8}$ in. thick, and is hung from the ends of five eccentric driven rocker arms. Its speed is 125 strokes per minute, which is of such relation to the forward movement of the machine that the area of the concrete touched at each stroke overlaps that touched by the preceding stroke. In consequence all portions of the road surface are struck twice with this tool, and considerable of the surplus water is brought to the surface. The spader blade is adjustable as a whole as to depth of stroke, and by separate adjustments of the drive bolts can be varied in contour.

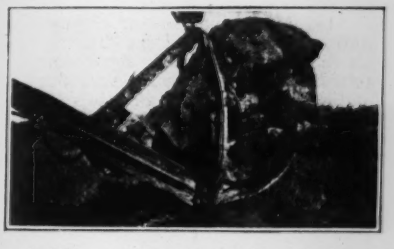
The tamper, a 4 in. channel mounted with flanges up, is hung from the rear



ends of the rocker, and has an alternate motion with that of the spader. It has a tamping and pressing action and its effect is over a greater area, but not as deep as that of the spader. The result of this action is to fill all surface and interior voids with mortar, and at the same time press out practically all of the remaining water, leaving the surface in an almost finished condition, and true to contour. This member has adjustment similar to that of a spader, both as to length of stroke and contour.

Tilting Dipper for Dredges

A dredge dipper which discharges by tilting forward so as to tip out its load instead of dropping it through the bottom of the bucket, is being marketed by the Bay City Dredge Works, Bay City, Mich. This new dipper has been used on drainage work in Wisconsin



and Minnesota and, it is stated, will handle any material but is particularly successful in handling sticky soil or soil containing boulders or roots difficult to drop through the regulation bottom-discharging dipper. The dipper is made in capacities of from $\frac{1}{2}$ cu.yd. to 2 cu.yd.

Out-of-the-Ordinary Trade Publications

The KOEHRING CO. of Milwaukee has issued a small booklet written by Philip Koehring of the company entitled "Built To Endure." It is most attractively illustrated in color sketches. The scheme of the book is to compare on opposite pages ancient and modern structures of somewhat similar natures, such, for instance, as the Acropolis at Athens with the Bush Terminal; the Coliseum at Rome with the New York Yankees' stadium; the Roman viaduct at Nimes with the Tunkhannock viaduct. All of the modern structures are of concrete.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Contracts for First Quarter of 1922 Promise Active Summer Construction

All Construction Exceeds $700,000,000—Residential $250,000,000—Contracts of Last Six Months $1,360,000,000

Volume of summer construction can be fairly gaged by the number and value of contracts awarded in the first quarter of this year. Seventeen hundred sixty-nine important engineering contracts were let in the United States from Jan. 1 to Apr. 1, valued at $308,040,000—over $100,000,000 heavier than in the same period of 1921, and about $160,000,000 more than in the first quarter of 1913. These figures and those in Table 1 are compiled from Construction News, where minimum projects reach $25,000 each on public work and $150,000 in the case of commercial buildings. Residential building is not included, but is listed separately in Table II (F. W. Dodge figures) for the Northeastern quarter of the United States. Geographic distribution of contracts let, as reported by *Engineering News-Record*, is shown in the map and in Construction News, p. 239.

Smaller engineering construction contracts (jobs worth less than the minimum reported in Construction News) will easily aggregate 50 per cent of the value of the jobs reported. Thus, engineering construction already signed up and mostly underway exceeds $460,000,000 in the United States (about $50,000,000 for Canada). At least a quarter of a million dollars worth of residential construction was placed under contract in the first quarter. Total contracts for the first quarter therefore exceed $700,000,000. It must also be borne in mind that total contracts placed in the last quarter of 1921 reached $650,000,000. Probably one billion dollars' worth of construction is now under way.

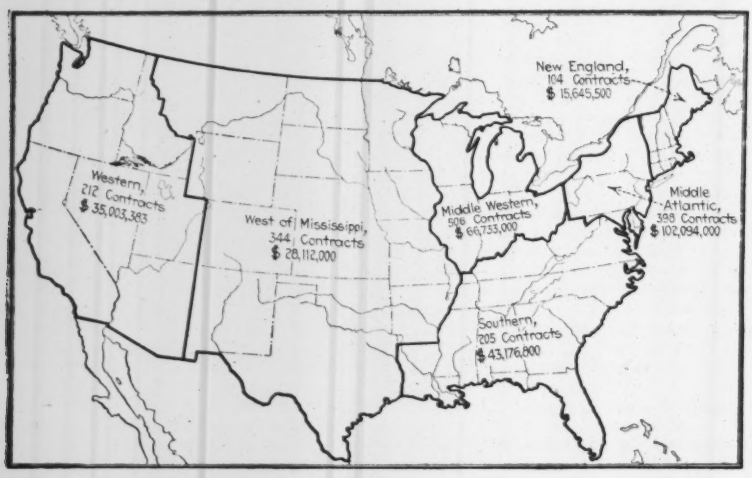
TABLE I—VALUE OF CONTRACTS LET IN THE UNITED STATES IN JANUARY, FEBRUARY AND MARCH, 1922

	New England	Middle Atlantic	Southern	Middle West	West of Miss.	Western	Total
Waterworks	$15,000	$734,000	$341,000	$888,000	$1,014,000	$550,000	$3,542,000
Sewers	32,000	2,453,000	809,000	3,503,000	894,000	342,383	8,033,383
Bridges	220,000	2,165,000	963,000	572,000	1,009,000	297,000	5,226,000
Excav. and dredging	68,000	25,000	329,000	108,000	531,000	294,000	1,355,000
Streets and roads	1,165,000	10,504,000	20,293,000	11,500,000	9,689,000	9,994,000	63,145,000
Industrial works	4,905,000	9,811,000	13,150,000	7,493,000	2,425,000	2,938,000	40,722,000
Buildings	8,776,000	54,433,000	6,113,000	41,708,000	15,415,000	19,304,000	145,749,000
Fed. Gov't. work	41,500	6,013,000	962,000	47,000		2,252,000	9,315,500
Miscel.	423,000	23,530,000	215,800	914,810	3,460,460	2,408,000	30,952,070
Total	$15,645,500	$109,668,000	$43,175,800	$66,733,810	$34,437,460	$38,379,383	$308,039,953

TABLE II—RESIDENTIAL CONTRACTS LET, FIRST QUARTER, 1922

District	Value
Boston	$9,578,300
New York	55,908,300
Philadelphia	20,178,800
Pittsburgh	13,076,600
Chicago	22,038,100
Minneapolis	1,786,200
Total	$122,566,300

DISTRIBUTION OF IMPORTANT CONTRACTS FOR FIRST QUARTER, 1922



Sixth Week of Coal Strike Brings No Solution

Stocks Outlast Early Estimates—No Solution Adequate that Fails to Stabilize Industry

The outstanding feature of the coal strike now approaching the end of its sixth week is the utter indifference of the public, which, as time rolls on, appears to increase rather than to break down. When the strike began it was estimated that anthracite stocks would be adequate for six to seven weeks. Since then the miners and operators have been in conference off and on but no conclusions have been announced. Anthracite production has been practically zero, but no one appears to be in the least alarmed over the possibility of immediate shortage.

Bituminous stocks, it was estimated, would be good for not less than two months. The miners figured that production during the strike would not run more than 3,500,000 tons per week, while the non-union operators counted on 5,000,000 to 6,000,000 tons per week. The fact is that weekly production hovers about 4,000,000 tons, which are supplemented by another 4,000,000 tons drawn from consumer stocks.

Immediately after the strike was called it began to make inroads on the non-union forces and today it is estimated that in central and western Pennsylvania alone more than 60,000 non-union miners are out. Despite this, the opinion prevails that lack of demand controls the output of the non-union mines and that if there were a market for it more coal could be produced.

Russell Sage Investigation

An investigation by the Russell Sage Foundation has disclosed that during the thirty years from 1890 through 1921 the bituminous mines have been open for work on an average of only 214 days per year. Based on a working year of 304 days, this means a loss of 90 working days, of which 37 per cent has been due to overdevelopment of the mines, which have a capacity of 700,000,000 to 900,000,000 tons annually to meet a demand of only 500,000,000 tons. Seasonal variation in demand is said to account for 47 per cent of the lost time.

It is generally recognized that radical readjustment is necessary if the industry is to be established on a stable basis and plans to accomplish this range all the way from government ownership to regional grouping of mine properties under private ownership, with standardized prices for the various sections of the country. Recent reports from Washington indicate that the President and his advisors are at work on the problem but no information is available as to the direction or progress of their thought except the intimation that they do not contemplate federal supervision. All things considered, it is probable that before June 1 conditions will demand some solution that will effect a prompt resumption of work in the mines.

"Ups" Balance the "Downs"

Is the Market Turning?—Construction 73 Per Cent Heavier Than a Year Ago

Looking over the *News-Record's* monthly prices in the May 4 issue one is rather startled by the numerous black-face figures. Bold-face type means higher prices. Light rails are higher by $1 a ton. Cast-iron pipe costs more in New York, Birmingham, Chicago and San Francisco than a month ago. Steel is recovering. Reinforcing bars are up in Pittsburgh, New York and Chicago. It won't be very long before Dallas and the Coast will reflect the new thrust. Prices of structural shapes are climbing. So with rivets. Steel sheets distinctly up. Lumber fairly steady, but a little downward.

By and large, prices are either holding their own or actually stiffening. Declines are fugitive: Sewer pipe cheaper in St. Louis, sand and gravel down in Chicago, cement one cent lower in Duluth, pine down $1 in Chicago, fir down $2 in San Francisco. Elsewhere prices are unchanged—or firmer.

Clearly prices are stiffening under the strong new construction demand. The "ups" just about balance the "downs." This is true throughout the list. *Engineering News-Record's* Construction Cost Index Number perfectly reflects the construction material and labor market. Last month 164.72, today 164.62.

Contracts let in April, 1922, as reported in Construction News, are valued at $142,800,000, as compared with $105,667,000 in April, 1921. Dividing each of these figures by the Cost Index Number applicable for the time, in order to reduce both values to 1913 purchasing power, gives only $50,000,000 for April, 1921, as against $86,600,000 for April, 1922. This means that contracts awarded last month were 73 per cent heavier *in volume* (not in mere money value) than contracts let in April one year ago.

This may explain why the market for construction materials is stiffening.

Next week—résumé of recent public bond sales.

Production and Materials Stocks in Ten Cities

Unfilled Steel Tonnage Gains—Brick Stocks Shortening—Growing Lumber Mill Shortage in Northwest

Steel—Unfilled steel tonnage on the books of the United States Steel Corporation on Mar. 31, 1922, aggregated 4,494,148 tons. Owing to developments in the coal strike this tonnage will be supplemented by an estimated gain of 500,000 tons, making the total unfilled orders for the month ending Apr. 30, 1922 amount to about 4,994,148 tons. Production increased about 2 per cent of capacity in the Corporation's plants, during the week ending May 6, bringing the output rate to about 73 per cent as compared with 70 per cent, for both the independents and the Corporation, on Apr. 26, 1922. Total pig iron production increased over 36,000 tons above March.

Cement — United States Geological Survey shows cement production 6,685,000 bbl. for March, 1922; an increase of 2,407,000 bbl. over February, 1922, and a decrease of 78,000 bbl. compared with March, 1921. March shipments increased 3,717,000 bbl. over February, 1922, and 781,000 bbl. over March, 1921. There were 13,824,000 bbl. on hand Mar. 31, 1922, as against 14,142,000 bbl. on Feb. 28, 1922.

Brick—Data as of April 1 from 100 plants reporting to the Common Brick Manufacturers' Association of America, show 39,000,000 bricks produced in March, with shipments 33,000,000. Number of burned bricks on hand totaled 22,969,000 as against 83,900,000 on Mar. 1, 1922. Current demand is moving the product about as fast as it can be burned.

Lumber—An average of 384 mills reporting to the National Lumber Manufacturers' Association for the four weeks ending Apr. 22, show 769,255,762 ft. cut; 831,148,266 ft. shipped and orders for 971,227,990 ft. b.m., as compared with 720,744,343 ft. cut; 743,469,637 ft. shipped and orders for 780,201,616 ft. during the month ending Mar. 25, 1922. Production for the week ending Apr. 29 was 7½ per cent below; shipments 9½ per cent and demand 22½ per cent above normal.

New York—Manufacturers' stocks of construction materials low, but dealers have sufficient stocks to meet all normal demands except in the case of brick. Manufacturers expect, by rushing production, to ship the first new brick into New York by June 1, unless prevented by further developments in the coal strike or the brickmakers strike.

Chicago—Brick deliveries being made at a rate about four-fifths of production capacity. Sand and gravel stocks over 200,000 cu. yd. Activity in sewer pipe demand in outlying districts. Expanded metal lath stocks low; deliveries take 3 to 4 weeks.

Detroit—Local cement mills speeding production. Prompt lime deliveries from Ohio and Michigan. Only moderate supply in local yards to meet increasing lumber demands.

Denver—Lumber shortage at mills supplying this market, but no deficit yet felt in local yards. About 1,000,000 bricks on hand.

Minneapolis — Stocks ample. Deliveries from plants slightly delayed. Lumber stocks larger, averaging 75@80 per cent of normal in Northwest trade area.

Philadelphia—Proposed reduction in sewer pipe and hollow tile prices causes falling off in demand. Asphalt and manila rope shipments very active. Supply of paving stone and wood block sufficient for present requirements. Lumber stocks, in yards, fairly complete with the exception of hard woods. Demand for all grades of lumber greater than expected.

Boston — Common brick market serious; also shortage of "water struck" brick. No reserve brick in New Hampshire to draw upon. Local output is sold faster than it can be produced.

San Francisco—About 25,000 M. ft. of lumber on hand and more arriving every day; demand increasing.

Atlanta—Sand and gravel delivered in 24 hr. from local pits; 3@4 cars of structural steel shapes on sidings.

Birmingham—Small stock of track supplies; but cast-iron pipe reserve large and complete. Structural steel

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (cement, Denver, 10,000 bbl.); time required for delivery of carload lots to city job, example: (sewer pipe, Boston, 8 to 10 days); and stocks on hand in general terms, example: (common brick, Atlanta, plenty)

	Chicago	San Francisco	Detroit	Denver	Boston	Atlanta	New York	Los Angeles	Birmingham
Sewer pipe	700 cars	Plenty, local kilns	Ample	24 hr. del. local plant	Large del. 8 @ 10 days.	Del. 48 hr.	Sufficient; del. prompt.	Plenty; del. prompt.	Local plants, large stocks.
Cement	Ample	1,000 bbl.; nearby mills	Plenty near Mich. mills.	10,000 bbl.	Plenty del. 5 @ 8 days.	35 cars.	60,000 bbl.	Sufficient	1,000 bbl.; 24 hr. from Leeds.
Lime, common and hydrated	40 @ 50 cars	Fair stock in local yards.	10 @ 15 cars	.....	Ample; quick deliveries	25 cars.	Moderate	.....	10 cars.
Common brick	100,000,000	Fair	.....	1,000,000	Shortage	Plenty	Shortage	Yards well stocked; del. 24 hr.	Local kilns; heavily stocked.
Hollow tile	Ample	3 @ 5 days from works.	Small supply; del. take several days.	.....	Sufficient	Del. 3 @ 4 days.	Large plants near city; shipments by water.	Large stocks in local yards.	Local plants; heavily stocked.
Lumber	Sufficient	25,000 M. ft.	Moderate supply in local yards.	Ample 24 local yards.	Large stocks in local yards.	Plenty	Del. 24 hr. Stocks large.	Plenty of fir; no pine or spruce	Large mills within 200 mi.
Asphalt	.....	Del. from refineries, 2 @ 3 days.	Small; del. take several days.	10 cars	.....	.....	Refineries near city.	.....	.....

manufactured locally. No market for paving blocks, sand, gravel or crushed stone.

Labor in pine industry constituted 37 per cent of the total cost of production in 1921, compared with 46 per cent in 1920, according to the Southern Pine Association. Skilled labor rates decreased 22 per cent during 1921.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of May 4; the next, on June 1.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	+$2.58	$3.35	$4.00	+$2.48	+$2.76	+$3.50	$3.10	+$3.60	$3.75
Structural rivets, 100 lb.	+3.50	3.90	5.50	+3.10	3.90	4.45	4.50	3.75	6.50
Reinforcing bars, ¾ in. and larger, 100 lb.	+2.48	3.25	3.50	+2.38	+2.66	3.42½	2.55	+3.60	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	61.15%	45%	59½%	61.9-5%	44%	+56.1%	53%	30.00
Cast-iron pipe, 6in. and over, ton	46.80@47.80	42.00	48.30	+44.10	48.00	+55.00	+51.00	+52.00	−50.00
Concreting Material:									
Cement without bags, bbl	+2.60	2.39	2.25	1.97	2.24	2.90	2.73	2.94	−2.48
Gravel, ¾ in., cu.yd	1.75	1.85	2.25	—1.80	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd	1.00	1.15	2.25	—1.80	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.75	1.90	2.73	1.60	2.25	3.50	2.25	3.00	2.00
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	48.00	36.00	+34.50	−40.00	39.00	+36.75	−26.00	20.00	47.00
Lime, finishing, hydrated, ton	15.80@16.80	18.00	25.00	18.00	29.00	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	2.75@3.18	1.25	2.50	1.40	1.40	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000	+21.40@23.40	9.00	11.15	11.00	15.00	12.00	15.00	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.0795	.115	.0821	.0752	.08	....	.12	−.09
Hollow partition tile 4x12x12, block	.11120	+.072	.115	.0657	....	.08	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	+.95	.96	1.09	+.99	+1.06	+1.12	+1.01	.86	−.97
Common Labor:									
Common labor, union, hour	.75	.35	.....	.80	.....	.50@.55	.56¼	.50@.60	....
Common labor, non-union, hour	.44@.60	.20	.25	.72½	.40@.50	.35@.50	.47½@.50	.....	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement and steel pipe delivered to contractors on job. Gravel ready mixed $1.75 per cu.yd.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to contractors in yards at San Francisco. Lumber price is for No. 1 fir, common.

Seattle quotes on Douglas fir instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks.

Montreal quotes on fir instead of pine. Sand, stone, gravel and lump lime per ton. Lime and tile are delivered; cement, sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 98.62 cents). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $30; 6-in., $110.

Changes Since Last Week

Price tendencies upward in principal construction materials. Steel shapes and reinforcing bars quoted at $1.60, Pittsburgh, with quotations creeping toward $1.70; the price of $1.50 per 100 lb. having very nearly disappeared from the market. Shapes and bars up 10c. per 100 lb. in New York, Chicago and Minneapolis during the last two weeks; stiff advances in Denver and Seattle. Stronger demand coupled with continued scarcity of pig iron reflected in rise in cast-iron pipe prices. Denver quotes $55 as against $52; Seattle $52 advanced from $51 and San Francisco $51 as compared with $50 per ton last week.

The coal situation, entailing increased production costs, has made itself felt in advanced cement prices, New York quoting $2.60 as against $2.40 per bbl. delivered, without bags.

Raw linseed oil quotations are above the dollar mark in four important centers, namely: Dallas, Minneapolis, San Francisco and Denver. New York price advanced 6c.; Chicago, 9c.; Minneapolis, 4c.; San Francisco and Denver, 7c. per gal. (5 bbl. lots).

Lumber prices, all grades, remain fairly firm throughout the country, Denver and Seattle, however, report growing mill shortages. Mills in the Seattle district are behind in shipments despite the fact that all operations are running full blast, with two shifts working. The labor situation at this point is practically stabilized with supply but trifle in excess of demand.

Common brick quoted in New York at $18@$20 as against $17 per 1,000 wholesale, last week. The Hackensack, Raritan, Staten Island, Connecticut and Haverstraw shipping centers, forwarding brick with all possible haste, cannot begin to fill the demand. The regular dealers' quotation of $18, advanced $1 during the week, was further supplemented by voluntary bids of $20 and higher on the part of buyers in order to obtain the much needed material. Strikes in the Raritan and Hudson River districts, coupled with shortage of coal and coal dust, add to the seriousness of the situation. Several manufacturers have granted wage increases in order to keep up production and negro labor from the South is being rapidly forwarded to plants supplying the New York market.